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COMMUNITY STUDIES ON PESTICIDES

Quarterly Progress Report #14
May 16 - August 15, 1968

California State Department of Public Health
Bureau of Occupational Health

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ABSTRACT

Quarterly Progress Report Number 14 covers the period May 16 - August 15,1968.

It presents progress made on the several work units within the project's 1968 Scope of Work and discusses at considerable length activities and preliminary findings in the Long-Term Study of Persons Occupationally Exposed to Pesticides, and in the Neonatal Jaundice Study.

A preliminary report from the California Department of Fish and Game on the effects of Azodrin on wildlife is presented in full.

A discussion of problems encountered in implementing a study on the Morbidity and Mortality of Poisonings is presented, together with a presentation of an in-depth and broad approach to the study which, it is believed, would result in valuable findings and conclusions.

The report includes brief statements on the progress made during the quarter on the Sputum Cytologic Study, Community Profile, Pesticide Residues in Human Autopsied Tissues and presents new work concerned with a Study of the Effects of Occupational Exposure to Lindane.

Finally, there are included investigative reports on three unique events including discovery of a mixed load of parathion and other chemicals with foodstuff; accidental contamination of a river with Endrin; and the use of 1080 (Sodium Fluoroacetate)and Zinc Phosphide in controlling a massive invasion of field mice into artichoke fields and questions arising therefrom.

Investigative reports on four fatal agricultural plane crashes are mentioned, reports on which have been forwarded to the Office of Pesticides in Atlanta.

LONG-TERM POPULATION STUDY

During the period of this report, baseline medical and biochemical data have been gathered on an additional 60 male workers from the University of California's Agricultural Extension Service. Forty of these men are Agricultural Extension Specialists and County Farm Advisors and are exposed to a variety of pesticides in the course of their work. The remaining 20 men, drawn from within the same organization, are 4-H advisors who do not work with pesticides but participate in the study as control subjects.

The objectives of this study and its planned procedure, together with a list of tests performed upon each participant, were presented in Quarterly Progress Report No. 12. In addition, as described in Report No. 13, each man received an exercise electrocardiogram and a pulmonary function determination.

During the period of this report, biochemical tests have been completed upon all the blood and urine samples taken from 29 pest control workers in the San Jose area whose examinations were reported in Quarterly Progress Report No. 13.

Of the blood taken from the 60 agricultural extension workers during this quarter, all of the samples have been tested for cholinesterase levels and approximately one-third of them have been tested for pesticide residues. Other blood and urine biochemistries from this group of workers are being completed as rapidly as possible. As these analyses are completed, the results are recorded on the appropriate forms and forwarded to the Office of Pesticides.

The RBC and plasma cholinesterase levels of the 4-H control group and the exposed pest control workers and agricultural extension workers are listed in Tables I and II and are summarized in Table III. The pesticide levels in the blood samples analyzed to date are listed in Table IV. Since, to date, only four blood samples from control personnel have been analyzed for pesticides, those results will be included with others to be determined and presented in subsequent quarterly reports.

TABLE I

Blood Cholinesterase Levels in Long-Term Study Participants' Control Group

Participants' Case Numbers	RBC Cholinesterase µM/min/ml	Plasma Cholinesterase µM/min/ml
LT-004	14.55	4.74
LT-006	12.69	4.24
LT-017	13.41	5.02
LT-019	12.32	4.05
LT-039	13.17	4.28
LT-043	12.81	6.34
LT-044	13.42	4.89
LT-050	13.68	3.17
LT-053	11.83	4.72
LT-056	12.18	5.48
LT-075	15.26	4.15
LT-105	11.94	5.34
LT-110	13.55	5.02
LT-129	14.31	4.85
LT-131	12.94	4.65
LT-149	15.40	3.84
LT-153	14.39	5.10
LT-171	11.83	5.47
LT-187	12.10	4.40
LT-195	15.40	4.93

TABLE II

Cholinesterase Levels in Long-Term Study Participants Exposed Workers

Participants' Case Numbers	Exposure Group*	RBC µM/min/ml	Plasma µM/min/ml
LT-001	1	15.30	6.18
LT-002	2	12.05	5.10
LT-005	2	14.75	5.76
LT-008	1	13.41	6.48
LT-010	2	13.60	5.12
LT-012	2	13.66	5.34
LT-014	2	12.52	6.28
LT-018	2	10.50	5.44
LT-020	1	12.30	5.08
LT-021	2	15.70	5.92
LT-023	1	11.97	4.24
LT-026	2	13.07	6.34
LT-029	1	13.70	4.47
LT-030	2	12.41	5.09
LT-033	2	11.34	4.12
LT-034	1	13.76	5.11
LT-035	1	10.89	3.11
LT-046	2	12.53	4.72
LT-057	2	15.50	3.62
LT-063	1	12.05	3.50
LT-064	1	14.39	5.24
LT-065	2	11.70	3.66
LT-070	2	15.50	4.34
LT-072	2	12.29	4.78
LT-074	2	11.65	3.68
LT-078	1	14.60	6.22
LT-079	2	13.52	4.42
LT-081	2	12.52	4.44
LT-082	1	10.67	5.44
LT-084	1	12.04	4.91
LT-086	1	12.93	5.16
LT-090	1	15.85	3.85
LT-091	2	14.05	6.17
LT-094	2	12.55	4.93
LT-096	1	13.77	3.89
LT-100	2	12.40	4.38
LT-101	1	12.65	6.20
LT-103	2	13.94	4.46
LT-104	1	11.76	5.11
LT-106	2	13.45	5.24
LT-109	1	7.51	4.40
LT-111	2	12.90	5.01
LT-112	1	13.61	5.31
LT-113	2	12.93	5.34
LT-114	1	11.03	5.33
LT-118	2	14.30	6.90
LT-121	2	12.15	6.00
LT-125	2	11.40	5.39
LT-136	2	11.31	6.30
LT-137	2	12.30	4.26
LT-141	2	14.50	5.67

TABLE II (cont'd.)

Participants' Case Numbers	Exposure Group*	RBC µM/min/ml	Plasma µM/min/ml
LT-145	2	13.05	6.00
LT-148	1	12.72	4.43
LT-158	1	11.84	3.67
LT-161	2	14.04	5.30
LT-163	2	14.06	4.26
LT-165	1	13.35	4.18
LT-169	1	14.41	4.87
LT-172	2	14.50	5.34
LT-177	2	13.64	5.80
LT-178	2	12.29	4.96
LT-183	2	11.77	3.34
LT-185	1	10.75	5.82
LT-189	1	12.30	2.78
LT-190	2	10.35	4.52
LT-191	1	10.39	4.26
LT-194	2	12.30	6.84
LT-196	1	12.51	4.71
LT-199	1	12.30	6.08

* Exposure Groups:

1. Pest Control Operators
2. Agricultural Extension Specialists and Farm Advisors

TABLE III

Long-Term Study
Summary of Cholinesterase Levels

Exposure Group	No. Persons	RBC µM/min/ml	Plasma µM/min/ml
1. Pest Control Operators	29		
Average		12.58	4.83
Range		7.51-15.85	2.78-6.48
2. Farm Advisors	40		
Average		12.99	5.11
Range		10.35-15.70	3.44-6.90
3. Control	20		
Average		13.36	4.73
Range		11.83-15.40	3.17-6.34

TABLE IV

Pesticide Levels in Long-Term Study Exposed Participants

Participants' Case Number	Exposure Group *	Pesticides Found in Blood in µgm/ml				
		p,p' DDT	p,p' DDE	Dieldrin	B-BHC	γ-BHC
LT-001	1	0.004	0.019			
LT-002	2	0.001	0.016			
LT-008	1	0.005	0.022	0.001	0.008	
LT-010	2	0.004	0.024	0.001		
LT-020	1	0.009	0.031	0.001	0.002	
LT-023	1	0.006	0.017	0.003		
LT-026	2	0.003	0.012			
LT-029	1	0.011	0.036	0.002	0.002	
LT-033	2	0.003	0.013			
LT-034	1	0.013	0.092	0.001	0.003	
LT-035	1	0.020	0.034		0.005	
LT-046	2	0.002	0.016			
LT-063	1	0.016	0.028	0.008	0.007	
LT-064	1	0.024	0.033	0.003	0.003	
LT-072	2	0.002	0.012			
LT-078	1	0.011	0.031	0.003		
LT-079	2	0.002	0.017		0.001	
LT-082	1	0.011	0.018	0.002		
LT-084	1	0.008	0.014			
LT-086	1	0.001	0.019			
LT-090	1	0.018	0.048	0.007	0.006	
LT-091	2	0.002	0.021			
LT-094	2	0.004	0.020			
LT-096	1	0.003	0.014			
LT-101	1	0.005	0.023	0.001		
LT-104	1	0.004	0.009			
LT-106	2	0.003	0.031			
LT-109	1	0.016	0.026	0.004		
LT-112	1	0.003	0.017			
LT-114	1	0.009	0.031	0.005		
LT-125	2	0.003	0.014			
LT-136	2	0.004	0.010			
LT-148	1	0.005	0.013	0.001		
LT-158	1	0.008	0.017			
LT-165	1	0.017	0.025	0.004	0.005	
LT-169	1	0.016	0.018	0.019		0.003
LT-178	2	0.001	0.016			
LT-185	1	0.021	0.043	0.004	0.002	
LT-189	1	0.004	0.018	0.004		
LT-191	1	0.010	0.024	0.003		
LT-194	2	0.002	0.010			
LT-196	1	0.009	0.019	0.004	0.002	
LT-199	1	0.006	0.017	0.002		

* Exposure Groups

1. Pest Control Operators
2. Agricultural Extension Specialists and Farm Advisors

NEONATAL JAUNDICE STUDY

The data collection processes were described in Quarterly Report #12 and selected preliminary statistics were presented in Quarterly Report #13. At the time of Quarterly Report #13, the staff reported an effective backlog of three weeks of uncollected data on the newborns and their mothers. The backlog has now been eliminated. This was made possible by the hiring of a part-time interviewer on July 1. The time released from interviewing has has been used by the permanent staff to eliminate the backlog in the collection of agricultural chemical data, to collect meteorological data for the period of the study, and to begin preliminary studies of the type of data analysis required.

Seven study months (December, 1967 through June, 1968) are considered in this report; as the work in progress on cases born in July has just begun, this work is not reported. In these seven months, 440 children were born in the two participating hospitals. Twenty-six of these children were born to families residing out of the study area and an additional fifteen did not receive bilirubin tests. Of the 399 children left in the study, 242 were born at El Centro Community Hospital and 157 at Pioneer's Memorial Hospital. Interviews have been attempted for 387 cases (the families of 12 cases are on vacation and interviews have not been attempted) and completed on 345. Thus, the percentage of success is 89.1%. Of the 42 families not interviewed, 27 had moved from the study area; in general, the wage earners of these families were either military personnel or farm workers. The remaining 15 of the 42 families not interviewed were "refusals"; these cases included uncooperative mothers, children with serious medical problems, and adoptions. There is no difference between the percentage of successful interviews of cases at the two hospitals. (See Table I.)

As stated in Quarterly Report #13, additional analyses were carried out during the quarter on the basic study group, the "allowed" cases. The group was obtained by the elimination of the following subgroups: 26 premature children(those with a gestation period of less than 37 weeks), 4 children with Rh incompatibility (Coomb's positive), and 13 children whose bilirubin tests were done before or after the statistically acceptable period of 49 through 108 hours after birth. Thus, 43 children in the study were eliminated, which left 356 in the "allowed" group, or 89.2% of the children in the study (See Table II).

When "allowed" mean bilirubin and standard deviations were calculated by month, both were consistently lower than had been obtained for the total study group. The decrease was greater for the standard deviation than the mean, as would be expected. (The mean bilirubin level of the premature children was 10 mgs% or more; many of the bilirubins taken too early or too late were very low.)

The "allowed" mean bilirubin level for the seven months of the study was 6.58 mg% with a standard deviation of 3.19. The values for ECCH are 6.48 mg% and 2.91 respectively, and for PMH were 6.78 and 3.62 respectively. The difference between the two means is not statistically significant.

As the standard deviations for the two hospitals are quite different, jaundice was defined for each hospital as one standard deviation above the mean for that hospital. At ECCH, 42 of the 224 allowed cases had bilirubin levels of 9.4 mg% or more (18.75%); 21 of the 132 allowed cases at PMH had levels of 10.4 mg% or more (15.91%). This difference is not statistically significant. By this definition, 63 of the 356 allowed cases were jaundiced (17.7%). (See Table III.)

Several tests were made on the "allowed" group; the combination of the cases from the two hospitals was justified statistically by using the different definitions of jaundice. At this point, it is necessary to emphasize the preliminary and temporary nature of these analyses. With the addition of new data each month, the mean and standard deviation change. Months with little jaundice have lower means and smaller variations. The data obtained so far are necessarily biased as only one month (December) with,retrospectively, an annually high rate of jaundice is represented; therefore, the overall mean, deviation, and consequently the definition of jaundice are lower than can be expected at the end of the study. Two points justify the work. The first is that the standard deviation will decrease as the size of the study increases, assuming a similar distribution. The second is that the error is on the right side; i.e., with a lower definition, there is less likelihood of finding significance.

The allowed doses were grouped by hour of first meal and whether or not they were jaundiced. Fifty-eight (58) infants were given their first protein meal within 15 hours of birth, 147 were fed from 16 through 20 hours after birth, 80 from 21 through 25 hours after birth, and 71 were fed for the first time 26 hours or more after birth. A X^2 test done for jaundiced/not jaundiced by this breakdown was not significant, but a breakdown of those fed within 15 hours of birth by those fed later tended toward significance (See Table IV).

The SES (socio-economic status) of each family is estimated by codes of from 0 through 15, 0 being lowest. When the code was developed, it was planned that Codes 0-3, 4-7, 8-11, and 12-15 would be natural breakpoints. The mean SES for the 307 cases coded for SES is 8.66. The breaks used are 0-5 with 49 cases, 6-8 with 82 cases, 9-11 with 130 cases, and 12-15 with 46 cases. The X^2 test using this breakdown by jaundiced/not jaundiced is significant at the 90% confidence level. ($X^2 = 7.066$, df=3, $p < .1$) the low SES group is significantly high in jaundice, the lower middle SES group is significantly low in jaundice and the upper middle and upper SES are unexceptional (See Table V).

Hemoglobin levels were found for 288 of the allowed cases. Twenty-three (23.5%) of the 98 cases with hemoglobin of 20 gm% or more were jaundiced, and 33 (17.4%) of the 190 cases with hemoglobin of less than 20 gm% were jaundiced. This difference is not statistically significant. This differs from the results stated in the last report because of the cases which are not allowed. Fourteen of the 22 cases which had hemoglobins and were eliminated from December, 1967, through March, 1968, had hemoglobins of over 20 gm% (See Table VI).

Of the 356 allowed cases, 124 were breast fed and 232 were bottle fed. The same percentage, 17.7%, of the bottle fed and the breast fed were jaundiced. (An earlier report which suggested that bottle feeding correlates with jaundice may have included premature children, most of whom are jaundiced and bottle fed while in incubators.) (See Table VII.)

There are 179 girls and 177 boys in the allowed group. Only 25 of the girls but 38 of the boys were jaundiced. This difference is significant at the 90% confidence level ($X^2 = 3.460$, df=1, $p < .1$). (See Table VIII.)

Data on agricultural chemical usage have been obtained for all cases born through May, 1968 (See Table IX). (As agricultural data are collected for six weeks retrospectively and there is a two to three week lag in obtaining the hospital data, agricultural data are up to date.) Again, only allowed cases will be considered. There were 307 allowed cases in this period. The definition of jaundice is 10.6 for PMH, 9.6 for ECCH. Using these definitions, 56 of the 307 cases (18.24%) are jaundiced.

Several attempts were made to find a correlation, either negative or positive, between the use of certain classes of chemicals and the bilirubin levels of the cases. Mean bilirubin levels for each month by hospitals were graphed against mean chemical usage in the six-seeks before the births of the corresponding cases. No correlation was found.

As the jaundiced babies seemed to be born in clusters, the staff next determined mean bilirubin and mean 6-week chemical usage by week. These means are not uniformly reliable as some weeks had as few as 4 cases and others had more than 20. Twenty-seven weeks were considered. The mean overall levels of chemical usage for the six weeks preceding the birth of the allowed cases is as follows:

Class of Chemical		Cases in Weeks Falling Over Mean		
	Mean	Total	Jaundiced	% Total
A Carbamate	5.81	129	19	14.7
B Chlorates	1.01	47	12	25.5
C Chlorinated Hydrocarbons	8.31	118	18	15.3
D Organo-phosphate	34.24	146	22	15.1
E Other inorganic	3.55	120	25	20.8
F Other organic	7.51	47	12	25.5

It is readily seen that weeks with more than the mean number of chemicals B, E and F have many more jaundiced cases than weeks with more than the mean number of chemicals A, C and D. For ease in discussion, let "Low B Weeks" mean weeks with neither chemical B, E nor F over its mean; let "High B Weeks" mean all weeks with at least one of three chemicals over its mean; let "Low A Weeks" mean weeks with neither A, C. nor D over its mean, and let "High A Weeks" mean weeks with at least one of the three chemicals over its mean. Then, the following combinations occur:

Low A n = 101 j = 23 % = 22.8
High A n = 206 j = 33 % = 16.0

Low B n = 176 j = 28 % = 15.9
High B n = 131 j = 28 % = 21.4

The X^2 tests for Low A/High A and Low B/High B were not statistically significant. (See Tables I and II.) The dichotomies were then crossed to give the following combinations:

Low A/Low B n = 63 j = 11 % = 17.46
Low A/High B n = 38 j = 12 % = 31.58
High A/Low B n =113 j = 17 % = 15.04
High A/High B n = 93 j = 16 % - 17.20

The X^2 test on this array was not statistically significant, but Low A/High B was very highly jaundiced and High A/Low B had low jaundice. The X^2 on these two combinations was significant at the 95% confidence level ($X^2 = 5.006$, df = 1, $p < .05$). (See Table IV.)

The same analysis was done with 3 week groups, which increases the reliability of the results obtained:

Low A n = 61 j = 8 % - 13.1
High A n = 246 j = 48 % = 19.5

Low B n = 185 j = 28 % = 15.1
High B n = 122 j = 28 % = 23.0

The X^2 test for Low A/High A was not statistically significant, but the same test for Low B/High B was significant at the 90% confidence level ($X^2 = 3.016$, $p < .1$).See Table V. The dichotomies were again crossed which produced the following combinations:

Low A/Low B n = 32 j = 2 % = 6.25
Low A/High B n = 29 j = 6 % = 20.7
High A/Low B n =153 j = 26 % = 17.0
High A/High B n = 93 j = 22 % = 21.5

The X^2 on the array is statistically significant at the 90% confidence level. Low A/Low B is significantly low in jaundice and High A/High B is significantly high. The X^2 on these two combinations is significant at the 95% confidence level ($X^2 = 5.173$, df = 1, $p < .05$).

The use of two separate definitions of jaundice becomes less imperative in the analysis of the agricultural data. In fact, it may be too conservative. The problem arises in the first place because of the greater standard deviation in the mean bilirubin levels of babies born at PMH. The mean monthly usage of agricultural chemicals in the six weeks before birth by hospital shows that, in the months when the greatest variance among PMH babies occurred, there was a greatly higher mean chemical usage in the 25 square mile area surrounding PMH children. Thus, the use of the two definitions doubly compensates for the higher variance, if chemical usage actually correlates with jaundice. In addition, the number of children born at PMH is substantially lower than the number born at ECCH. This tends to make the PMH variance proportionately greater, given a similar distribution of bilirubin levels, and decreases the weight of the chemical usage for PMH children.

Further analysis was done for these reasons; the same tests and definitions as were used above were used, but jaundice is defined as 10.0 mg%, one standard deviation above the total mean for December, 1967, through May, 1968. Fifty-four cases (17.6%) are jaundiced under this definition. Coincidentally, this is the clinical definition of hyperbilirubinemia. First, weekly mean chemical usage was examined. Jaundice by class of chemicals is as follows under the new definition:

Chemical, mean 6-week usage	n	j	%
Carbamates ≥ 5.81	129	17	13.2
Chlorate ≥ 1.01	47	14	29.8
Chl/HC ≥ 8.31	118	20	16.9
Or-Phos ≥ 34.24	146	23	15.8
Inorg. ≥ 3.55	120	27	22.5
Org. ≥ 7.51	Same as chlorates		

The cases are divided into High A/Low A and High B/Low B in the following table:

Low A	n = 101	j = 21	% = 20.8
High A	n = 206	j = 33	% = 16.0
Low B	n = 176	j = 23	% = 13.1
High B	n = 131	j = 31	% = 23.7

As in the preceding cases, the Low A/High A dichotomy is not statistically significant, but the Low B/High B case is significant at the 98% confidence level ($X^2 = 5.821$, df = 1, $p < .02$). The crossed dichotomies in the following table again have a statistical significance: X^2 ($X^2 = 7.389$, df = 3, $p < .1$):

Low A/Low B	n = 63	j = 11	% = 17.5
Low A/High B	n = 38	j = 11	% = 28.9
High A/High B	n =113	j = 13	% = 11.5
High A/Low B	n = 93	j = 20	% = 21.5

As in the first case (separate definitions of jaundice and weekly means), the significant combinations are Low A/High B, which has high jaundice, and High A/Low B, which has low jaundice.

Finally, the 3-week periods were examined using the 10.0 mg% definition of jaundice. These cases were divided as follows:

Low A	n = 61	j = 10	% = 16.4
High A	n =246	j = 44	% = 17.9
Low B	n =185	j = 25	% = 13.5
High B	n =122	j = 29	% = 23.8

Again, the Low A/High A dichotomy is not statistically significant, and the Low B/High B dichotomy is highly significant ($X^2 = 5.334$, df = 1, $p < .02$). The crossed dichotomies in the following table are not statistically significant, but the Low A/Low B and the High A/High B combinations have suggestively low and suggestively high jaundice, respectively:

Low A/Low B	n = 32	j = 3	% = 9.4
Low A/High B	n = 29	j = 7	% = 24.1
High A/Low B	n =153	j =22	% = 14.4
High A/High B	n = 93	j =22	% = 23.7

In all four analyses just presented, the Low A/High B combination has the highest or next to highest percentage of jaundice; and the High A/Low B has the lowest or next to lowest percentage of jaundice. The statement: More than mean usage of chlorates and/or other inorganics and/or other organics in the absence of more than mean usage of carbamates and chlorinated hydrocarbons and organo-phosphates increases the probability of jaundice is therefore a preliminary hypothesis which must be tested in the final analysis. An additional hypothesis can be formed: More than mean usage of carbamates and/or chlorinated hydrocarbons and/or organo-phosphates in the absence of more than mean usage of chlorates and other inorganics and other organics decreases the probability of jaundice.

In three of the four analyses, the Low B/High B dichotomy was statistically significant, in that, in a given period, the proportion of jaundiced children with a mean exposure to more than the mean number of chlorates and/or inorganics and/or organics was significantly higher than the proportion exposed to less than the mean number.

The difference in the proportion jaundiced between the three-week mean periods, with jaundice determined in one case by hospital mean bilirubin level and in the other by the overall mean bilirubin level, was less extreme than in the one-week periods. This is explained by the greater reliability of the means for the three-week periods. For this reason, two other hypotheses are suggested: 1) that Low A/Low B has a significantly low proportion of jaundice and, 2) that High A/High B has a significantly high proportion of jaundice.

As the amount of time expended on even this indefinite and possibly premature analysis of agricultural data was excessive, and the complexity of the relationship which seems to exist between agricultural chemical usage and hyperbilirubinemia can better be resolved by a computer, no further preliminary analysis is planned on the subject.

In the following quarter, the staff will continue to collect the data already being pursued. In addition, work will begin on the actual preparation of the data for computer programming. Also, the staff plans to collect data on the feed lots in the 25 square mile areas surrounding the homes of children in the study.

TABLE I

Cases of Interview Status x Month by Hospital
December, 1967 - June, 1968

							Completed Interviews		Uncompleted Interviews		
	Total	Reside out of County	No B/R Done	In Study	Pending Completion	Attempted Interviews	Total	% of Total Attempted	Total	Moved out of County	Refused, M.D.," Adoption
Total	440	26	15	399	12	387	345	89.1	42	27	15
ECCH	265	18	5	242	7	235	211	89.8	24	18	6
PMH	175	8	10	157	5	152	134	88.2	18	9	9
Dec.'67	68	2	4	62	0	62	60	96.8	2	2	0
ECCH	34	1	2	31	--	31	29	93.5	2	2	--
PMH	34	1	2	31	--	31	31	100.0	0	0	--
Jan.'68	60	6	1	53	0	53	46	86.8	7	4	3
ECCH	39	5	1	33	--	33	29	87.9	4	3	1
PMH	21	1	--	20	--	20	17	85.0	3	1	2
Feb.'68	67	4	2	61	0	61	53	86.9	8	3	5
ECCH	38	3	1	34	--	34	31	91.2	3	1	2
PMH	29	1	1	27	--	27	22	81.5	5	2	3
Mar.'68	70	4	1	65	0	65	59	90.8	6	3	3
ECCH	38	2	--	36	--	36	33	91.7	3	2	1
PMH	32	2	1	29	--	29	26	89.7	3	1	2
Apr.'68	64	4	2	58	0	58	52	89.7	6	4	2
ECCH	43	4	--	39	--	39	35	89.7	4	3	1
PMH	21	--	2	19	--	19	17	89.5	2	1	1
May'68	55	5	0	50	1	49	43	87.8	6	5	1
ECCH	35	2	--	33	--	33	28	84.8	5	4	1
PMH	20	3	--	17	1	16	15	93.8	1	1	0
June'68	56	1	5	50	11	39	32	82.1	7	6	1
ECCH	38	1	1	36	7	29	26	89.7	3	3	0
PMH	18	--	4	14	4	10	6	60.0	4	3	1

TABLE II

Cases by Allowed x Month by Hospital
December, 1967 - June, 1968

	Total	Reside Out of County	No B/R Done	IN STUDY					
				Total	Coomb's +	Gest. <37 wks.	B/R Taken Early or Late	Allowed	% of Total in Study
Total	440	26	15	399	4	26	13	356	89.2
ECCH	265	18	5	242	0	13	5	224	92.6
PMH	175	8	10	157	4	13	8	132	84.1
Dec.'67	68	2	4	62	1	8	6	47	75.8
ECCH	34	1	2	31	-	3	4	24	77.4
PMH	34	1	2	31	1	5	2	23	74.2
Jan.'68	60	6	1	53	0	0	3	50	94.3
ECCH	39	5	1	33	-	--	1	32	97.0
PMH	21	1	--	20	-	--	2	18	90.0
Feb.'68	67	4	2	61	0	2	1	58	95.1
ECCH	38	3	1	34	-	2	-	32	94.1
PMH	29	1	1	27	-	--	1	26	96.3
Mar.'68	70	4	1	65	1	5	1	58	89.2
ECCH	38	2	--	36	-	1	--	35	97.2
PMH	32	2	1	29	1	4	1	23	79.3
Apr.'68	64	4	2	58	2	3	1	52	89.7
ECCH	43	4	--	39	-	2	--	37	94.9
PMH	21	--	2	19	2	1	1	15	78.9
May'68	55	5	0	50	0	7	1	42	84.0
ECCH	35	2	--	33	-	4	--	29	87.9
PMH	20	3	--	17	-	3	1	13	76.5
June'68	56	1	5	50	0	1	0	49	98.0
ECCH	38	1	1	36	-	1	--	35	97.2
PMH	18	--	4	14	-	--	--	14	100.0

TABLE III

Mean Bilirubin Level[1] with Standard Deviation
x Month by Hospital

	TOTAL			ECCH			PMH		
	n	$\bar{x}$	s	n	$\bar{x}$	s	n	$\bar{x}$	s
Dec.'67	47	7.61	3.54	24	7.32	2.98	23	7.91	4.12
Jan.'68	50	6.32	3.02	32	6.26	2.86	18	6.42	3.36
Feb.'68	58	6.93	3.59	32	6.46	2.79	26	7.52	4.36
Mar.'68	58	6.27	2.97	35	6.17	3.00	23	6.42	2.99
Apr.'68	52	5.95	3.20	37	5.79	3.00	15	6.34	3.74
May '68	42	7.05	3.33	29	7.60	3.42	13	5.83	2.86
Dec.-May	307	6.66	3.30	189	6.52	3.04	118	6.88	3.68
June'68	49	6.06	2.36	35	6.11	2.11	14	5.94	2.99
Dec-June	356	6.58	3.19	224	6.46	2.91	132	6.78	3.62

[1] excluding out of county, Coomb's positive, premature and bilirubins taken too early or too late.

TABLE IV

Hour of First Meal
x Cases Jaundiced
with % of Total
December, 1967 - June, 1968

	Total	Jaundiced	% Total
Total	356	63	17.7
10-15 hrs.	58	14	24.1
16-20 hrs.	147	25	17.0
21-25 hrs.	80	9	11.2
26-30 hrs.	60	11	18.3
> 30 hrs.	11	4	36.4

$(X^2 = 1.835, df=1, p<.2)$

TABLE V

SES x Cases Jaundiced
with % of Total
December, 1967 - June, 1968

	Total	Jaundiced	% Total
Total	307	57	18.6
0-5	49	13	26.5
6-8	82	8	9.8
9-11	130	28	21.5
12-15	46	8	17.4

TABLE VI

Child's Hemoglobin
x Cases Jaundiced
with % of Total (Dec.'67-June'68)

	Total	Jaundiced	% Total
Total	288	56	19.4
HGB 12-16 gm%	35	7	20.0
" 16-20 gm%	155	26	16.8
" ≥ 20 gm%	98	23	23.5

TABLE VII

Method of Feeding x Cases Jaundiced
with % of Total
(Dec.'67-June'68)

	Total	Jaundiced	% Total
Total	356	63	17.7
Breast*	124	22	17.7
Bottle	232	41	17.7

* includes breast & bottle

TABLE VIII

Sex x Cases Jaundiced
with % of Total (Dec.'67-June'68)

	Total	Jaundiced	% Total
Total	356	63	17.7
Male	177	38	21.5
Female	179	25	14.0

TABLE IX

Mean Chemical Sprayings x Month by Hospital
Allowed Cases: December, 1967 - May, 1968

	n	Carbamates	Chlorates	Chlorinated Hydrocarbons	Organo-Phosphates	Other Inorganic	Other Organic
Total	307	5.81	1.01	8.31	34.24	3.55	7.51
PMH	118	3.72	1.30	6.86	38.68	3.47	9.85
ECCH	189	7.12	0.82	9.20	31.41	3.60	6.06
Dec.'67	47	2.47	6.51	14.83	52.62	5.04	21.43
PMH	23	2.61	6.70	16.08	68.26	4.48	28.47
ECCH	24	2.33	6.33	13.62	37.62	5.58	14.67
Jan.'68	50	3.68	0.06	7.00	18.40	0.98	5.46
PMH	18	4.33	0	5.56	27.11	0.11	6.50
ECCH	32	3.31	0.09	7.81	13.50	1.47	4.88
Feb.'68	58	5.59	0	7.78	31.76	0.76	2.98
PMH	26	5.69	0	3.85	38.27	0.08	2.42
ECCH	32	5.50	0	10.97	26.48	1.31	3.44
Mar.'68	58	7.14	0	8.48	49.53	1.84	4.88
PMH	23	1.91	0	4.87	42.87	0.17	7.09
ECCH	35	10.56	0	10.85	53.90	2.94	3.43
Apr.'68	52	10.26	0	8.13	32.46	4.05	6.27
PMH	15	3.93	0	5.80	18.13	6.60	5.20
ECCH	37	12.84	0	9.08	38.27	3.03	6.70
May'68	42	5.05	0	3.24	16.88	10.50	5.79
PMH	13	3.85	0	3.15	19.62	15.31	6.54
ECCH	29	5.59	0	3.28	15.66	8.34	5.45

CONCERNING THE USE OF AZODRIN

The occurrence of suspected Azodrin poisoning among humans in California's San Joaquin Valley during the 1967 crop-growing season was reported in Quarterly Progress Report No. 11. At that time, we reported upon the results of an investigation made in response to inquiries from concerned cotton farmers and public officials in the Hanford, California, area who feared kill off of wild birds and domestic pets and illness among farm families when Azodrin insecticide was used extensively in the cotton fields. From the investigation, it appeared at that time that no harmful effects to human health resulted from exposure to Azodrin.

During 1968, Azodrin has been used since early July for control of bollworm and mites on cotton. By August 1, the use of this material had become extensive in Fresno, Kings, Tulare, and Kern Counties where approximately one-half million acres of cotton are under cultivation.

Under Section 2461 of Title 3, California Administrative Code, crop dusting and spraying personnel are required to be under medical supervision. In partial fulfillment of the Code, workers have routine blood cholinesterase determinations made at several medical laboratories throughout the State. One such laboratory has recently brought to the attention of the project staff the fact that their determinations upon employees of those companies applying Azodrin indicate that practically all personnel have very low plasma cholinesterase--less than 0.2 delta pH units/hr., with some as low as 0.09, while red blood cell cholinesterase is in the low normal range.

It appears that Azodrin may be a selective human plasma cholinesterase inhibitor. In this regard, the project's staff will make further inquiries as the season progresses to this particular medical laboratory and others in the cotton-growing areas as well as to the Fresno Poison Control Center.

Because of the toxicity of Azodrin to wildlife, the California Department of Fish and Game conducted in 1967, and are again conducting in 1968, field and laboratory tests on the effect of the chemical upon several species of wildlife found in the cotton-growing areas of the State. A copy of that Department's report of the tests conducted during 1967 follows. Results of the 1968 tests will be included in future Quarterly Progress Reports as they become available.

AZODRIN WILDLIFE INVESTIGATIONS IN CALIFORNIA[1]

INTRODUCTION

In June 1965, Azodrin, an organic phosphate, was registered by the California Department of Agriculture for the control of certain insect pests in California cotton fields. The chemical received limited use during the cotton growing season of that year. In 1966, due to a production set back, Azodrin was not generally available for use in California. In 1967 Azodrin was available for operational use and was applied extensively in cotton growing areas of the San Joaquin Valley.

The Department of Fish and Game first became aware of the potential adverse side effects of Azodrin in 1965 as a result of wildlife losses associated with its application in cotton fields. However, field studies conducted by the Department in 1965 and 1966 did not indicate that Azodrin as applied to cotton was extremely hazardous to birds. These studies suggested that Azodrin was not as hazardous to wildlife as certain other organic phosphate insecticides in common use. Laboratory tests conducted at the Fish and Game Field Station showed that pheasants and quail were not particularly susceptible to Azodrin in spray form. However, oral toxicity tests revealed that Azodrin is one of the most toxic of all agricultural chemicals used in California to birds.

The Department's concern over numerous losses of wildlife in cotton fields led to field studies in five San Joaquin Valley counties during 1967. Investigations were made to assess the cause of wildlife losses and to obtain data regarding ecological relationships of birds to cotton fields.

This report includes data on Azodrin-wildlife relationships collected during field and laboratory investigations conducted by the Department of Fish and Game in 1965, 1966 and 1967. This information indicates that the current Azodrin use practices for control of insect pests in cotton present a substantial hazard to bird life. However, important factors have not been identified which would explain how present Azodrin use practices cause wildlife losses. Suggestions are presented as guidelines for research designed to determine these unknown factors. It is anticipated that research will lead to the development of safeguards for wildlife in any future use of Azodrin.

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[1] Prepared by the California Department of Fish and Game Federal Aid Project FW1R, "Pesticides Investigations Project" - December 1967.

1965 STUDIES

Four incidences of dead or affected birds were investigated in Fresno, Kings and Tulare counties in 1965. In three of four cases, the losses were associated with the use of Azodrin in cotton fields. In the other instance the specific pesticide involved was not determined. However, several organic phosphates and one chlorinated hydrocarbon had been used in the general areas where losses occurred.

Six immature pheasants from among the affected birds observed in Fresno County were captured and submitted to the Department of Fish and Game Field Station for examination. It was determined that cholinesterase activity in brain tissue was inhibited approximately 65 percent of normal. This indicated that the birds were exposed to an organic phosphate insecticide.

Bioassays using pheasants and quail were conducted by Fish and Game personnel in Kern and Tulare counties cotton fields to obtain a measure of the hazard of Azodrin to wildlife. Birds were placed in wire cages in cotton fields and exposed to an aerial application of Azodrin. In the Kern County test, debility and mortality occurred among the birds within 24 hours after the application. The Tulare County test was inconclusive because predators had disturbed the cages on successive nights, destroying several of the test birds.

In addition to the field studies, toxicity tests were conducted at the Department's Field Station to obtain additional evidence regarding the effects of

Azodrin on wildlife. Pheasants, sprayed with Azodrin at the rate of 0.9 pounds of actual material per acre failed to exhibit symptoms of poisoning. Pheasants subjected to as many as ten spray applications at this rate, did not show symptoms of poisoning either. Oral toxicity tests were also conducted. It was found that the LD_{50} of Azodrin was 1.95 mg/kg for male and 1.55 mg/kg for female pheasants.

1966 STUDIES

In 1966 no wildlife losses from pesticides were reported from cotton producing areas of the San Joaquin Valley. Azodrin was not generally available for operational use in California although a limited amount of this insecticide probably was applied.

Several cotton test plots under study by the University of California Agricultural Extension Service near Arvin, Kern County, were made available to the Department of Fish and Game for Azodrin wildlife studies. Immature and adult pheasants were exposed to an aerial application of Azodrin at a rate of 0.9 pounds per acre. In this bioassay, pens enclosing 100 square feet were used to allow test birds free movement in seeking food and shelter as contrasted to the 8 square foot cages used in the 1965 trials. The study area was irrigated immediately after application. Immature pheasants exhibited symptoms of poisoning but recovered within 24 hours. Adult test pheasants showed no ill effects of exposure to Azodrin.

1967 STUDIES

Field Investigations

The first report of wildlife losses was received the last week of August from the Department of Fish and Game Region 4 office in Fresno regarding three instances of losses of game and nongame birds in cotton fields. Preliminary investigations suggested that Azodrin was implicated in these losses.

Members of the Department's Pesticide Investigations Project met with Region 4 personnel to discuss the wildlife loss situation. It was apparent that a potential existed for wide-scale losses to occur and that a surveillance program was needed to collect information on the side effects on wildlife of Azodrin applications.

Regional personnel were requested to locate fields where Azodrin was to be applied and to check these fields for wildlife losses. The locations of treated cotton fields were obtained through contacts with pest control operators, agricultural commissioners and growers. Observations were made at these fields and findings recorded on a standardized form. Information was obtained regarding: (1) formulation of pesticide used, (2) methods and rates of application, (3) cultivation practices at the fields, (4) types of crops on adjacent fields, (5) the numbers of affected and dead birds observed, and (6) the wildlife population in the general area.

Thirty-five reports of wildlife losses were received by the Department of Fish and Game. Field investigations were made of 22 of these reports. The occurence of dead or affected wildlife were verified in 19 of the instances reported. In three instances, no evidence of losses was found. The remaining 13 reports, received from county agricultural commissioners and citizens, also indicated that losses did occur, but actual evidence of mortality was not obtained. Therefore these 13 instances are not included in the wildlife loss record.

Wildlife involved in the die-offs were pheasants, doves, quail, jackrabbits, horned larks, meadowlarks, blackbirds, killdeer and sparrows. Reports of dead feeder geese were also received. In addition, several ranchers reported losses of peacocks. A hunter reported that one of his dogs died after retrieving several birds from a cotton field treated with Azodrin. The reported losses of domestic animals were not substantiated.

The number of dead and affected birds recorded per incident varied from 1 to 29. It is emphasized that these figures do not relfect the actual extent of losses as only the edges of treated fields were searched for carcasses. The Department assessed the impact of Azordin on wildlife primarily by the numbers of verified instances of losses rather than the total number of wildlife affected.

It became apparent early in the investigation, that carcass searches were not practical in dense cotton, particularly in those fields under irrigation. Visibility and movement of investigators was restricted in mature cotton fields to the extent that accurate carcass counts could not be made. In addition, the hazard to personnel of Azodrin was not known. As a safety precaution Fish and Game personnel were requested to stay out of treated areas for three days after application.

Crop dusters reported that shortly after spraying, sick pheasants in cotton fields were clearly visible from the air. The Department's airplane was used on September 13 in an attempt to locate pheasants in cotton fields that had been sprayed with Azodrin. No wildlife was observed in the treated fields during the mid-day flights. The usefulness of aerial observations in spotting affected birds could not be assessed. However, the aerial survey proved useful in spotting standing water in the interior of fields, that was not evident from the ground. Field data suggests that water may be an important factor in Azodrin wildlife losses, as water was present in the majority of the fields where affected birds were observed (Table 1).

Observations of pheasant movements made during the surveillance program showed that this species utilized cotton fields extensively for cover. It appeared also, that part of their diet was composed of vegetable and animal matter from cotton fields. A food habit study was made to obtain data on the actual role of cotton fields in providing food for pheasants and several other species of birds.

TABLE I

Surveillance Program in Azodrin-Treated Cotton Fields (1967)

Date	Field Location County	Pesticide Application Rate	Wildlife* Sick	Wildlife* Dead	Field Under Irrigation	Samples Collected for Residue Analyses
8-67	Fresno	Azodrin-1½pt.	x	x	Yes	Yes
	Fresno	Azodrin-1½pt.	x	x	Yes	Yes
	Fresno	4-2-1, Mix**	o	x	Yes	Yes
	Kings	4-2-1, Mix**	x	x	4 days after appl.	No
	Fresno	Azodrin ---	x	x	Adjacent to field	Yes
9-67	Madera	Azodrin-1½pt.	x	x	Yes	Yes
	Fresno	Azodrin ---	o	x	Yes	No
	Madera	Azodrin-2 pt.	x	o	Yes	No
	Madera	Azodrin-1½pt.	x	o	Yes	Yes
	Fresno	Azodrin ---	o	x	No	No
	Madera	Azodrin-½ pt.	x	o	Yes	Yes
	Madera	Azodrin-1½pt.	o	o	Adjacent to field	No
	Madera	Azodrin-1½pt.	x	x	Damp	Yes
	Madera	Azodrin-2 pt.	o	o	No	No
	Tulare	Azodrin-1½pt.	o	x	---	Yes
	Fresno	Azodrin ---	o	x	---	Yes
	Fresno	Azodrin-½ pt.	x	o	Adjacent to field	No
	Madera	Azodrin ---	x	o	Yes	Yes
	Tulare	Azodrin ---	o	x	No	Yes
	Madera	Azodrin-1½pt.	o	o	No	No
	Fresno	4-2-1, Mix**	x	o	Adjacent to field	Yes
	Fresno	4-2-1, Mix**	x	o	Adjacent to field	Yes

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* x - observed; o - not observed
** Toxaphene-DDT-Azodrin

Analyses were made of crop and gizzard contents of birds found dead or affected near Azodrin-treated cotton fields. In addition, eighteen pheasants and ten blackbirds were collected during September from cotton fields that had not been treated with Azodrin.

The results showed that the diet was virtually the same for pheasants collected in both treated and untreated fields. About two-thirds of the food was vegetable and one-third animal matter. The vegetable matter was mostly seeds of Johnson grass, cup grass and watergrass which grow commonly on ditch banks and cotton fields. The animal matter was primarily adult insects (Hemiptera and Coleoptera) and immature larva (Lepidoptera). As many as seventy larvae plus adult insects were present in the crops of pheasants. It is reported in other food habit studies that animal matter generally contributes less than 4 percent to the diet of adult pheasants.

Animal matter comprised 44 percent of the diet of blackbirds found dead in Azodrin-treated fields and 18 percent of the diet of birds collected from untreated cotton fields. The food of meadowlarks was entirely animal matter. Over half, or 54 percent of the crop contents of quail was also animal matter. This amount of animal matter in the diet of quail is unusually high compared with results obtained in other studies. The crop or gizzard contents of dove, horned larks and sparrows were mainly vegetative material, although there were trace amounts of larva and adult insects (Table 2).

Most of the species of insects and vegetation present in the crops of both game and nongame birds may also be found in or adjacent to cotton fields. It would appear, from the limited number of food habit analyses made, that Azodrin contaminated feed may have been involved in the debility of birds.

TABLE II

Percent Animal & Vegetative Matter in Crop or Gizzard Samples
of
Birds Associated with Cotton

Species	Composition of Diet	Cotton Field: Azodrin Treated: Crop	Cotton Field: Azodrin Treated: Gizzard	Cotton Field: Not Treated with Azodrin: Crop	Cotton Field: Not Treated with Azodrin: Gizzard
Pheasant	Animal Matter	38(4)*	trace	25(18)	34
	Vegetable Matter	62	100	75	66
Valley Quail	Animal Matter	54(8)	4	--**	--
	Vegetable Matter	48	96	--	--
Blackbird	Animal Matter	--(8)	44	--(10)	18
	Vegetable Matter	--	66	--	82
Dove	Animal Matter	trace(4)	0	--	--
	Vegetable Matter	99.9	100	--	--
Horned Lark	Animal Matter	--	trace(6)	--	--
	Vegetable Matter	--	99.9	--	--
Meadowlark	Animal Matter	--	100(3)	--	--
	Vegetable Matter	--	0	--	--
Sparrow	Animal Matter	trace(4)	17(6)	--	--
	Vegetable Matter	99.9	83	--	--

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* ( ) indicates number of birds in sample
** -- No samples

The Department's surveillance program ended the third week of September, because for all practical purposes the use of Azodrin in 1967 terminated at that time. The abrupt stop in applications forced cancellation of two experiments scheduled for later in September. A bioassay to determine the toxicity to birds of Azodrin-contaminated insects from treated fields was not carried out because of the lack of suitable insects. However, 26 dead insects were collected and homogenized in an osterizer and force fed to one pheasant without adverse effects. Plans were also canceled to conduct a thorough carcass search on a treated field to assess in detail the effects of Azodrin on wildlife.

In October, the Shell Chemical Company requested information regarding cultural practices in cotton fields where wildlife losses had occurred. Department personnel accompanied representatives of the Shell Company to six fields to assist them in obtaining this information. Following this field trip a joint inspection was made of a cotton field where an experiment was being conducted by Shell Chemical Company. Information was being obtained on Azodrin residue levels on cotton foliage and in irrigation water following prescribed application procedures. Water samples were being collected in jars which were located in the field and on adjacent ditch banks. Numerous samples of cotton foliage were also included in the sampling program.

Laboratory Investigations

Water samples and affected and dead wildlife were collected from Azodrin-treated cotton fields for laboratory studies during the Department's surveillance program. Necropsy showed that all birds were in good flesh and not diseased. Crops and gizzards were removed for food habits studies and tissue samples were taken for pesticide residue analyses.

A method was sought to determine whether Azodrin residues were present in samples taken during the surveillance program. A literature search and contacts with personnel involved in pesticide residue analyses revealed that there was no specific method available for detection of Azodrin in animal tissues. An enzymatic method was availble for the analyses of residues in foliage and milk samples. As a result of additional inquiries, it was learned that the U. C. Agricultural Toxicology Laboratory at Davis had recently developed a GLC procedure, with thermionic detection for phosphorus, which specifically identified Azodrin and degradation products. Researchers at the U. C. Laboratory suggested that the procedure might be applicable to analyses of animal tissues.

This laboratory volunteered to run a limited number of tissue samples provided we supply tissues taken from birds known to have died from Azodrin. In order to obtain appropriate samples three pheasants were given a 5 mg/kg dose of Azodrin administered orally. All test birds died within one hour and were autopsied. Livers of the three birds were composited into one sample, as were the kidney and the brain tissues. The U. C. laboratory was successful in detecting Azodrin and some metabolic degradation products in each sample. However, these residue levels were not quantitated.

Samples of liver, kidney and brain tissues from quail and pheasants which had been found dead in Azodrin-treated cotton fields were also analyzed by this laboratory. Residues of Azodrin and Bidrin Acid, a degradation product, were detected at a level of 0.011 ppm and 0.15 ppm, respectively in the pheasant liver sample. Remaining tissue samples of pheasants and quail indicated only trace amounts of Azodrin and Bidrin Acid.

The California Department of Agriculture Chemistry Laboratory in Sacramento also identified Azodrin in pheasant tissue with the method used by the U. C. Agriculture Toxicology Laboratory. Samples supplied to the Department of

Agriculture Laboratory were from a pheasant which had died within one hour after receiving a 5 mg/kg dose of Azodrin. Azodrin was detected at a level of 0.3 ppm in kidney, 0.4 ppm in brain, 0.1 ppm in liver tissues and 3.9 ppm in the crop.

Five water samples were collected during the field investigation and submitted for residue analyses. Two of these samples were taken from the same field at two and nine hours after the spray application. A water sample from another field was taken within eight hours after application. Azodrin was detected in these three water samples. The highest level, 0.6 ppm, was reported for the water sample collected two hours after application.

The remaining two water samples were taken from the site of a fish kill which occurred in a drainage canal adjacent to a cotton field which had been treated with 4-2-1 mix (Toxaphene, DDT, and Azodrin). Although Azodrin was not detected in these samples, DDT and Toxaphene were present at levels that have caused fish mortality (Table 3).

Contacts and Meetings

On August 28, the Shell Chemical Company office in San Francisco was notified that Azodrin was implicated in wildlife losses in Fresno County. They were advised that the Department was initiating a surveillance program to assess the side effects on wildlife of Azodrin applications in the San Joaquin Valley.

On September 12, Department personnel met with staff members of the State Department of Agriculture in Sacramento to present the findings of the surveillance program. Concern was expressed by the Department of Fish and Game over the numbers of incidences of wildlife losses attributed to the use of Azodrin. On the following day, staff members of the Departments of Agriculture and Fish and Game met with personnel of the Shell Chemical Company's San Francisco office in Sacramento to discuss the findings of the surveillance program and to determine a course of action to prevent additional wildlife losses. From the standpoint of the Department of

TABLE III

Residue Analyses of Water Samples

Location	Source of Sample	Pesticide Applied	Sampling Time	Residues Detected in ppm Azodrin	Toxaphene	DDT	Laboratory
Road 22, Avenue 4, Madera Co.	Furrow	Azodrin	2 hrs. after applic.	0.663	-	-	U.C. Davis
Road 22, Avenue 4, Madera Co.	Furrow	Azodrin	9 hrs. after applic.	0.014	-	-	Dept. Agric. Sacramento
Road 26, ½ mile So. of Howard, Madera Co.	Pot hole	Azodrin	Less than 8 hrs. after applic.	0.04	-	-	Dept. Agric. Sacramento
Brittan Ranch, Fresno Co.	Ditch adjacent to field*	4-2-1 mix	5 hrs. after applic.	-	0.015**	0.006	Dept. Agric. Sacramento
Brittan Ranch, Fresno Co.	Ditch adjacent to field*	4-2-1 mix	6½ hrs. after applic.	-	0.003	0.002	Dept. Agric. Sacramento

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* Fish loss reported

** The concentration of both DDT and Toxaphene in water is usually sufficient to kill fish.

Agriculture, the evidence presented during the meeting of September 13 did not warrant immediate withdrawal of the chemical. However, it was agreed that there was a need for a modification of the recommended use practice. Growers were to be informed immediately by Shell Chemical Company that Azodrin should not be applied to cotton fields under irrigation. This restriction was based on circumstantial evidence that Azodrin-contaminated water might be implicated in wildlife losses.

All parties agreed that Shell had the responsibility of developing safeguards for wildlife in Azodrin use programs. The Departments of Agriculture and Fish and Game offered assistance in developing testing programs aimed at determining the cause of wildlife losses as well as providing information necessary for the development of safeguards for the protection of wildlife.

Regional Fish and Game and Shell Company personnel met in Fresno on September 14 to discuss plans for action at the local level. It was suggested that a carcass search be made in an Azodrin-treated cotton field to assess the effects of Azodrin on wildlife. Personnel of the Shell Chemical Company offered to collect insects from Azodrin-treated fields to be used in oral toxicity tests and to assist the Department in locating a treated field suitable for a carcass count.

Another meeting was held in Sacramento on September 22 by staff members of the two organizations. Current progress of the surveillance program was discussed and it was disclosed that neither the proposed carcass count or the feeding trials could be successfully undertaken because the use of Azodrin had terminated for the season. Shell Company personnel provided the Department with analytical procedures used in their laboratories for the detection of Azodrin by the GLC method. The two organizations planned to meet again following the completion of reports on current field and laboratory investigations.

DISCUSSION

The finding of dead wildlife in cotton fields treated with Azodrin in 1965 indicated that this use practice was hazardous to wildlife. Bioassays conducted in the field later in 1965 and 1966 indicated that birds were not particularly susceptible to dermal exposures of Azodrin. These assays did not provide data on oral toxicity of food and water contaminated by this chemical. However, the numerous losses that occurred in 1967 demonstrated that the current Azodrin use practice for the control of cotton pests presented a significant hazard to bird life.

Wildlife losses attributed to Azodrin were found in 19 of 22, or in 85 percent of the incidences investigated by Department personnel in the San Joaquin Valley. At least 8 species of wildlife were known to be affected. The numbers of sick or affected birds found in each incident was relatively small but no effort was made to obtain a complete mortality count.

Additional information regarding the hazards to wildlife from Azodrin have been documented by the Arizona Department of Game and Fish and the U. S. Bureau of Sport Fisheries and Wildlife. Cooperative investigation involving these agencies were made in the Cibola area near Blythe. A preliminary account indicated that 365 dead birds were found in twelve and a quarter miles of cotton field "edge" searched by personnel of these agencies. A total of 17 bird species were included in the carcass counts. Gambel's quail were the hardest hit; 171 dead and 19 sick were recorded. Observers reported that the most impressive factor was not the number of carcasses counted, but the lack of living birds in treated areas where bird life had formerly been abundant. From these accounts it would appear that the losses were more dramatic in Arizona than in California.

The San Joaquin Valley is recognized as one of the major cotton producing areas of the United States. In 1967, approximately 550,000 acres were allotted to cotton in this Valley. It was estimated that over one million acre applications of Azodrin were made to cotton fields in California, mostly in the San Joaquin Valley. (One acre application is equivalent to one acre treated one time). The evaluations made in the Department's surveillance program involved observations on less than 2,000 acres. Effects on wildlife on the remaining cotton acreages treated with this pesticide is unknown.

The diversified agriculture of the San Joaquin Valley provides ideal habitat for many species of wildlife. Cotton fields, particularly those that are bordered by fields of grain, alfalfa, sugar beets and safflower, are particularly important to bird life. They supply food, shelter and escape cover for both game and nongame birds. Greatest utilization of cotton fields by birds probably occurs in mid-summer and fall after the small grain and certain row crops have been harvested.

A measure of the importance of cotton producing counties of the San Joaquin Valley in producing game birds can be obtained from hunter success data. In 1966 Fresno County led the state in the number of pheasants bagged. Five of the remaining counties in the San Joaquin Valley were among the leaders in the take of other species of upland game. The portion of the take that occurred in cotton producing areas was not delineated. However, it is recognized that birds, particularly pheasants, from these areas account for a significant portion of the total take.

Nongame birds inhabit or frequent every type of habitat in California, including cotton producing areas. This widespread distribution and availability make them the most observed wildlife in the state. Human use of this resource consists mainly of observation, photography and scientific study.

An example of the importance of nongame wildlife to the public is expressed in a recent day use survey of State wildlife areas. The survey indicated a noticeable increase in the numbers of visitors utilizing these areas for the aesthetic enjoyment of wildlife. Reports from one State wildlife area indicate that day use for aesthetic enjoyment of wildlife is greater than the day use for hunting purposes. The interest and responsibilities of the Department of Fish and Game in protecting nongame wildlife may not be generally recognized. The State Legislature has delegated the responsibility for the protection of both game and nongame wildlife to the Department (Chapter III, Article 1, Section 1000 of the Fish and Game Code).

There are many questions that remain unanswered in the assessment of the hazards of Azodrin to wildlife. The answers to some key questions may be available only through future field study of Azodrin wildlife relationships. Unfortunately we cannot call on present knowledge of these relationships or past experience in the evaluation of side effects of other pesticides to obtain needed understanding of this problem. However, comparing Azodrin-wildlife relationships with those involving other pesticides provides insight into why this problem is unusually difficult to solve. Comparisons and past experience also provide an indication of the factors that should be included in the full assessment of side effects of Azodrin on wildlife.

Azodrin has chemical and toxicological properties that are somewhat different from most other organic phosphates in common use. It is much less toxic dermally but more toxic orally than are parathion and other insecticides in this family that are highly toxic to birds. The fact that Azodrin is low in dermal toxicity was a factor that indicated its use might be less hazardous to wildlife than other organic phosphates.

Azodrin has a very high rate of elimination from the animal body. In tests with rats, 85 percent of the chemical was degraded and excreted within 24 hours after intake. This factor suggests that there would be no latent biological problems involving the accumulation of this material in the animal body. The rapid degradation of Azodrin in tissues presents a problem from an analytical standpoint in that the analysis may not be conducted in time to detect residues in affected wildlife. However, in our studies, residues of Azodrin were found in tissues 27 days after exposure to this chemical. These samples were taken from dead birds picked up in fields treated with Azodrin and held in a frozen condition for 25 days prior to residue determinations.

Azodrin is more stable in water than most other organic phosphates. This suggests that contamination of water utilized by wildlife may be a factor to consider in the case of this insecticide. Chemicals such as parathion that hydrolize rapidly have not been implicated in wildlife losses through contamination of water.

It has been reported in both laboratory and field investigations that some exposed wildlife develop symptoms of poisoning then recover. The accumulative effect, if any, of multiple exposures to Azodrin is not known. It is not known, for example, whether resistance to the toxic effects of the chemical may be lowered by multiple exposures. The effect Azodrin caused debility may have on increasing the susceptibility of wildlife to predation and other mortality factors has not been determined.

The multiple use of a highly effective broad spectrum insecticide over a wide area may also effect the food supply of wildlife. This type of effect is difficult to identify except by long-term wildlife population and food habit studies. The likelihood of indirect effects on wildlife populations resulting from the altering or reducing of the food supply, should be considered in the overall evaluation of Azodrin.

The use of Azodrin in California's agriculture has followed a different pattern than has been the case with most of the other widely used insecticides. The acceptance of this material by growers has been spectacular. Whereas the use of most new chemicals increase rather gradually over a period of years on the basis of demonstrated effectiveness. The use of Azodrin skyrocketed during 1967, the first full year it was generally available on the California market. As was previously stated, approximately 1 million treated acres received Azodrin during 1967.

As a result of the rapid acceptance of this chemical, biological implications resulting from the wide-scale use of Azodrin have not been documented. It has been common with the slower acceptance of other pesticides to build up knowledge of side effects over a period of years. Under such circumstances specific uses that resulted in undesirable side effects were usually identified and corrected without appreciable effect on the overall use of the pesticide and before the scope of the problem became large. The case of Azodrin must be handled with particular care and dispatch because: (1) major changes in the use of this chemical may seriously reduce the effectiveness of controlling insect pests of cotton, and (2) adverse effect on wildlife will result if changes in the current use practices are not made before wide-scale use of this material is resumed.

A rather unique concept in multiple treatment has been recently introduced into California. This concept involves scheduling the frequency of spray application on a calendar basis rather than on pest abundance. As many as 23 insecticide applications at 5 or 7 day intervals were made during a recent bollworm control program. We are concerned that the adoption of "treatment by the calendar" may result in the unnecessary exposures of fish and wildlife to pesticides. If applications are made routinely without prior field inspection, then some unnecessary treatments may be made. Should this concept be generally adopted for the use of pesticides, particularly broad spectrum insecticides, adverse effects are apt to occur.

The label for Azodrin in California presently calls for two applications three days apart. In 1967 some growers made as many as eight applications of Azodrin in a two month period. There has been some indications that future use recommendations for this material in California will follow those presently used in other states. Recommendations in those states include provisions for multiple applications on a calendar basis throughout the infestation period. The potential for additional hazard encompassed in "treatment on a calendar basis" should be evaluated carefully in any future Azodrin use practices in California.

It is readily apparent that assessment of the full impact on wildlife of Azodrin will require study over a period of years. However, there are some aspects of Azodrin-wildlife relationships that should receive consideration before further commercial use of Azodrin is permitted. Highest priority should be set on determining how Azodrin effects wildlife. Tests are needed that establish the type or types of exposure that result in death and debility of wildlife. For example, the significance of dermal exposure, inhalation and ingestion of contaminated feed and water should be investigated. Studies involving exposure of wildlife to Azodrin, which stimulate the types and amount of exposure occurring under actual field conditions, should provide the leads necessary to determine how animals become debilitated by this chemical. Establishing the route or routes of exposure that result in losses should logically lead to the development and consideration of safeguards needed to prevent a reoccurrence of the losses that occurred in 1967. It would also appear logical that the effectiveness of any proposed changes be assessed before unlimited use of Azodrin is permitted in 1968.

Specifically, consideration should be given to conducting bioassays with species of wildlife that were involved in the losses reported in cotton fields. Natural feed of birds, including both vegetable and animal matter as well as water should be contaminated with various levels of Azodrin and fed to test birds. The singular and combined effect of exposure by inhalation and by direct spraying or contact with contaminated foliage should also be incorporated into the testing program.

There is also a pressing need to decide upon an analytical procedure that can accurately and effectively identify Azodrin and its metabolites in animal tissues and components of the environment. In the past, both GLC and enzymatic procedures have been used in analysis for Azodrin. The enzymatic method does not appear to provide the specificity needed in the analysis of samples taken from the field, particularly when Azodrin and other organic phosphates have been used. The GLC method for detection of Azodrin is new and has not received widespread acceptance by residue laboratories. Lack of sensitivity in the GLC method may create a problem in obtaining large enough samples when levels of contamination are particularly low. However, one analytical method should be selected in order to provide a uniform system of measuring residues in the basic studies being planned for this year.

The effects on both fish and wildlife of Azodrin in combination with other insecticides should be investigated. This is of importance if Azodrin is to be applied with other insecticides in the future. Azodrin combined with DDT and toxaphene (4-2-1 mixture) was the toxicant implicated in 4 of the 22 instances of losses investigated by the Department in 1967. In one of these instances a sizable fish kill occurred presumably caused by the toxaphene DDT phase of the 4-2-1 mixture.

An equitable solution to the Azodrin-wildlife problem is important to all concerned in California, Arizona and the rest of the nation. An opportunity is available to demonstrate the effectiveness of cooperative action between the chemical industry and local government in solving problems without undue outside interference. Considerable national and local attention has already been focused on the outcome of the next few months cooperative endeavor. It will require a great deal of understanding, patience and hard work on the part of personnel of Shell Chemical Company, the State Departments of Agriculture and Fish and Game and other participating agencies to successfully accomplish what needs to be done.

It has been established that the primary responsibility for developing adequate safeguards for fish and wildlife in Azodrin use practices lies with the Shell Chemical Company. We will make every effort to assist in the planning and implementation of the necessary research activities and to assist in the incorporation of these and other research findings into use practices that provide adequate insect control without undue hazard to wildlife.

MORBIDITY AND MORTALITY STUDY OF POISONINGS

I. Introduction

There are many reasons to believe that present knowledge about the extent of illness and death from pesticides and other poisons is inadequate for the designing of prevention or treatment programs which are as effective as they might be. Estimates of the proportion of the iceberg which is submerged from sight range from 20% to 97%; or, to put it the other way, the most optimistic view estimates that 80% of poisoning incidents are reported through Workmen's Compensation, poison control centers, or other mechanisms; estimates range all the way down to one which holds that only 3.4% of all cases find their way into any kinds of channels where they can be retrieved for analysis and program planning purposes. On the other hand, in some forms of poison reporting, there is a certain amount of overreporting. No one knows for sure how much, but it is almost certainly less than the amount of underreporting.

The twenty-five fold disparity in estimates of how much is known and how much is unknown about poisonings is a fair indication of the imprecision of existing data. Such imprecision is clearly too great to be tolerated in any scientific or even quasi-scientific undertaking.

II. Scope of the Work Unit

The purpose of the work unit is to arrive at the most informed estimates possible of the true parameters of death and illness from pesticides and other poisonings in the State of California. Given the limitations of one staff position, and one year, most aspects of the study can be only exploratory and tentative, pointing the way toward more definitive studies.

With one or two exceptions, noted below, the present study will be limited to the scrutiny of data already gathered through other agencies and mechanisms. Most of these data are believed to understate the true incidence of morbidity and mortality from poisons. A rigorous check on the extent of understatement, however, requires nothing less than new mechanisms. It is out of the question to suppose that a whole new mechanism could be tested and instituted within the limitations of time and personnel noted. But it is to be expected that the present study will arrive at recommendations as to the new methods required, the time and space over which they should extend, and the resources they would absorb.

The present study will also be limited with respect to the amount of epidemiological detail it can develop. It is recognized that, ultimately, a well-designed program of prevention or control must rest on a great wealth of detail about not only the numbers of persons affected but who they are: their age, sex, education, occupation, income, diet, housing, recreation, family status, mobility, and many other possibly relevant variables. Again, the Morbidity and Mortality Study of Poisonings may be thought of a precursor to what may later come. The first step along the road is to learn something more than we now know about the sheer numbers of people affected. This facilitates later steps. Knowledge of the extent of the problem is necessary before one can design an epidemiological study with a sample large enough to yield findings which are statistically significant.

This is not to say there will be no classification of data by age, sex, or other traditional epidemiologic categories in the present study. It is to say that the emphasis, during this first year, will be on staking out the magnitude of the problem; attention will be paid to subdivisions within those broad frontiers, but only as time permits.

One other basic methodological point must be stressed. The overwhelming emphasis of this study will be on data which make it possible to calculate rates of illness or death. There is no shortage of purely phenomenological accounts of poisonings. Almost any day, one may read in the newspaper of some disaster, such as a family wiped out because the mother mistook ant powder for baking powder. Anecdotal evidence may serve as the point of departure for more substantial knowledge, but it cannot substitute for it. One needs a frame of reference; one needs to know. "How often does this sort of thing happen, in terms of the total population at risk?"

Most of the existing sources of information about poisonings are not of a sort which permit the calculation of incidence rates. To mention a few: reports of poison control centers; hospital emergency rooms; office records of interested physicians. Such materials are undoubtedly valuable for some purposes, but they share a shortcoming which is fatal to the purposes of the present study: they rest upon no precise, or even approximate, population base which can serve as the denominator in the calculation of rates. Private physicians in this country do not serve a defined panel of families and individuals. Neither do hospital emergency rooms.

As far as poison control centers are concerned, what is the "population at risk?" The population of the county in which they are located? Obviously not. The Fleming Memorial Poison Information Center in Los Angeles has received telephone inquiries from twenty-five counties, twelve states, two countries, and assorted ships at sea. Operationally, it seems clear, the "population at risk" consists of unknown numbers of lay persons who happen to have heard of the Center, and unknown numbers of physicians and hospitals which happen to know of the Center. The Fleming Memorial Center received 1,178 telephone inquiries about pesticides in 1965; 1,545 in 1967. We cannot draw from such figures any conclusions as to the incidence of pesticide poisoning in Los Angeles County, California, or elsewhere. We cannot even make a broad qualitative statement that pesticide poisonings are increasing. We can only say that 31% more calls about pesticides were received by this particular center, whatever that proves; it could well mean that the incidence of pesticide poisonings has actually decreased, but that more physicians have become familiar with the work of the center.

III. Definitions

A. "Poisoning." Although the initial and primary concern of the study was pesticides, it was early decided to broaden the scope of concern. From existing information, it is sometimes impossible to discriminate with certainty between pesticide poisonings and other types of poisonings. For example, an agricultural laborer is discovered dead in an irrigation ditch, a field, or a bunkhouse; a gross autopsy may rule out stroke or cardiovascular disease as the cause of death, and point toward accidental poisoning, but there may not be sufficient local facilities, skill, or interest to pinpoint the type of poison. It would be unfortunate if such a case were lost to our study simply because it could not be proved beyond all cavil that it was due to an agricultural chemical.

Perhaps even more to the point, if prevention of poisonings is the aim--as it is--then it seems excessively arbitrary to include the case of the child who opens a cabinet and eats a rodenticide but exclude the infant who opens the same cabinet and eats the detergent or drinks the cleaning fluid which is next to the rodenticide. The etiology of the episodes is essentially the same, and so is the indicated course of prevention.

To the extent that the present study will be dependent on work already done by others (see Data Sources I, II, and III, below), it will be dependent on their definitions of "poisoning." Some, for example, include only accidental poisonings. Some include deliberate poisonings as well, whether self-inflicted or inflicted by others.

To the extent that we are in a position to proceed from our own conception, it is as follows: "a poisoning is defined as a state of illness or death among humans which is caused by entrance into the organism of any agent which chemically produces the injurious or deadly effect." This is a very broad concept, which includes, among other things:

1. Solid, liquid, and gaseous substances, whether they are ingested, injected, inhaled, absorbed through the skin, or enter into the organism in any other way.

2. All such episodes, regardless of intent (accidents, suicides, and homicides), and regardless of location(home, industry, recreational area, etc.).

3. Substances which under ordinary circumstances are harmless or even beneficial (e.g., penicillin reactions and other chemotherapeutic misadventures).

4. Substances which are not "poisonous" in the short run, but which result in a cumulative body burden over a period of years, eventually resulting in disease or death (e.g., Laennec's cirrhosis; carcinoma of the lung among welders, asbestos workers, smokers; etc.).

5. Animal, insect, and reptile venom.

6. The old and new sources of "mind expansion" and "kicks": glue-sniffing, LSD, marijuana, heroin, etc.

7. Edibles which are intrinsically poisonous (e.g., toadstools, oleander, castor beans).

Although our conception may be broader than some, there is much that it does not include. For example, it does not include, what laymen customarily refer to as "food poisoning," which is, in fact, not due to the foodstuffs per se, but to shigella, salmonella, staphylococcus, or other microorganisms. No conditions caused by bacteria or viruses are included in our concept.

Furthermore, comprehensive as we may try to make our data, they will necessarily be understated because our knowledge about the long-term effects of many types of contaminants which have been added to the body burden in recent years is still in a very primitive state. No one yet knows what will be the ultimate impact on health of the small residues of pesticides which began to appear in the average diet only within the past ten or fifteen years. No one can say for sure what will be the result of the radioactive fallout which humans began to absorb during approximately the same period. It is currently a matter of debate within the public health community whether, and to what extent, hydrocarbons, oxides of nitrogen, and other automobile exhaust emissions adversely affect city dwellers. If they do, they should be considered poisons as surely as the exhaust which persons bent on suicide pipe directly into their sealed cars. But the evidence is not all in.

B. "Illness." Mortality is comparatively easy to define (although modern medical technology is making even death less clearcut than it was as recently as a year ago). Morbidity, however, has always been subject to differential definition, and there is no generally agreed-upon understanding today any more than there has ever been.

As before, when we rely on the studies of others, we have no choice but to use their definitions. Thus, for example, in Data Sources II and III, below, the operational definition of poisoning morbidity was that it came to the attention of a physician. This tells us nothing about how serious it was. Indeed, in an unknown, but probably substantial, proportion of these cases, there may not actually have been a poisoning at all. The parent came home to find a toddler playing with an empty bottle of medicine. Maybe the medicine was poured down the sink, or disposed of in some other way. But it would be foolish to take a chance. The child is rushed to the hospital or to the physician's office; his stomach is pumped out, an antidote is administered, or whatever. The case is lumped together with those in which it is certain that medicine was, in fact, ingested.

An entirely different conception of morbidity was used in Data Source I, below. Here, the criterion was not medical attendance. There are, after all, many reasons why even quite serious poisoning episodes may never come to professional attention: e.g., personal stoicism, ignorance, geographical remoteness from medical facilities, lack of ability to pay. For many purposes, it would seem, a more useful criterion is extent of incapacity. This can range from permanent and total disability, through permanent partial disability, temporary total disability, temporary partial disability, to those conditions which the informant can only describe as "I didn't feel as well as usual."

In the one sub-study for which we are in a position to establish our own definition of morbidity, Data Source V, we shall attempt to employ a three-dimensional conception. A case will be included if it meets any one or a combination of the three following criteria: (1) brought to the attention of a physician, public health nurse, or other professional attendant; (2) demonstrated by laboratory test or other clinical means to be outside the range of the physiologically "normal"; (3) symptoms reported by the patient, combined with exposure to a chemical agent, plausibly point toward an authentic poisoning episode.

Thus, for example, an orange picker with red cell cholinesterase activity of 0.15 Δ pH/hr. would be considered "ill" even if subjectively he felt "well." An orange picker who reported in the middle of a working day that he felt giddy and nauseated, that he was having difficulty focussing his vision, and was perspiring more profusely than usual might well be considered a pesticide poisoning case even it it were not possible to perform red cell, plasma, or whole blood cholinesterase screening, and even if the case never came to a physician for treatment.

IV. Data Sources

A. California Health Survey.

The California Department of Public Health sponsored statewide sample surveys of morbidity in 1954, 1958, and 1961. Since these surveys consisted of interviews in a representative sample of all the households in the state, they meet the crucial methodological criterion suggested above: i.e., they rest upon a known population base which may be used as a denominator in the computation of incidence rates.

Many of the results of the California health surveys have never been published. They exist in books of mechanical tabulations which contain far more detail on causes, extent, and duration of disability, and demographic characteristics of the victims, than has ever been extracted, codified, and analyzed. The first sub-study of the Morbidity and Mortality Study of Poisoning will consist of the detailed examination of this data source for all cases with International Statistical Classification codes of N 960-979. The findings will be expressed in terms of rates for the total noninstitutional population of California.

B. Childhood Accident Study.

For some years, the Family Research Center of the California Department of Public Health studied childhood accidents of various types--including poisonings. One of the Center's approaches was to examine the complete medical records of 8,874 children who were (1) members of families subscribing to the Kaiser Foundation Health Plan; (2) residents of Berkeley or Oakland, California; (3) enrolled in the plan for a minimum of four consecutive years. The study population consisted of persons at least 4 years old, but not older than 18.

Here, as in the previous data source, there is a wealth of detail which has never been published. The present study does not propose to repeat material which is already generally available in the literature, but proposes to make an original contribution by extracting new data from the files of the Family Research Center and presenting it in prose, tabular, and graphical forms.

Information from this source will be more limited than that from Data Source #I in various ways. It will be limited in terms of age groups covered. It will be limited to the extent that the population enrolled in the Kaiser Foundation Health Plan may not be representative of the population as a whole. It will be limited to cases which came to medical attention.

On the other hand, cases obtained from medical records have an advantage over cases of self-reporting in that the information is likely to be more clinically precise, and is not compromised by the fallibilities of the human memory.

C. California Medical Assistance Program.

Under Title XIX of the 1965 amendments to the Social Security Act, California initiated on March 1, 1966, a broad program of care for the medically indigent. Under the program, commonly known as Medi-Cal, a comprehensive scope of "mainstream" medical care benefits is available to all public welfare recipients, and to an additional group of "medically needy" who are not on welfare but whose resources are inadequate to meet their health care needs. Nearly 1,500,000 persons are eligible for benefits at the present time.

The Data Processing Center of the California Department of Public Health receives computerized information on every service paid for by the Medi-Cal program: physicians' services, drugs, hospitalization, etc. The computer tapes include codes which identify the person receiving the service, the person or institution performing the service, the date, type of service, amount of payment, and, of special interest for our purposes, the primary diagnosis.

At least a million and a quarter claims are processed each month. With hand operations, or even with punch cards, it would be unfeasible to sort through a series of such enormous magnitude. With a modern computer, however, it becomes possible to pluck out from this vast data bank those cases which meet a particular criterion, or, if one wishes, a complex set of criteria. We propose to identify all poisoning cases treated under the Medi-Cal program during the months of June through December, 1966, and June through December, 1967. This will allow for a possible seasonal variation between summer and winter, and will hopefully reveal whether there has been any significant change in incidence from early in the program to a more recent period. (Due to late billings and payment delays, there is a time lag of close to a year before one may be sure that the file for a given month actually represents all the services rendered in that month. Therefore, it is unlikely that any month more recent than December, 1967, can be used.)

The Department's Data Processing Center also maintains an "eligibility file"--tapes containing certain information about all the persons eligible for Medi-Cal, month by month. This represents the population base. By putting the eligibility file and utilization file together, it is possible to calculate incidence rates: not only crude rates, but age-specific, sex-specific, and cause-specific rates, differential rates by county, and so forth.

As time permits, it would also be feasible to obtain from the Medi-Cal data bank information on severity of poisonings, as reflected in number of physician visits, days of hospitalization, costs, etc.

The most obvious disadvantage of this data source is that the population is, by definition, poorer than the population at large, with the corollaries of inferior education, bad housing, and the other disabilities which accompany poverty. Such variables may tend to make the accident experience of the Medi-Cal population atypical.

However cautious one may have to be about extrapolating from Title XIX recipients to any other segment of the population, the advantages of the Medi-Cal data bank are impressive. With the possible exception of the Title XVIII (Medicare) data bank maintained by the Federal government, the California Department of Public Health's tapes on the Medi-Cal program represent the largest computerized file of health care information in the country and perhaps in the world. One and one-half million people are a great many people, and 30,000,000 records are a great many records. In a series of this magnitude, relatively infrequent conditions which may not appear at all in a small sample survey, begin to appear in sufficiently large numbers to allow statements about frequency with a reasonable degree of statistical reliability.

To be sure, the data from this source are limited to cases receiving medical attention, and it is possible that the poor tend not to seek professional care for relatively minor or merely suspected cases of poisoning. On the other hand, there are some reasons to believe that there may be less underutilization than found, for example, in the more affluent Kaiser Foundation population. Unlike members of the Kaiser plan, Medi-Cal recipients have complete freedom of choice of practitioners and facilities.

Theoretically, at least, the Medi-Cal program represents a "true" utilization experience--i.e., a picture of what one might expect of the general population if all economic barriers to health care were removed.

D. Death Certificate Study.

All statements about deaths from poisoning in California, to date, are based on death certificates--or, to be more precise, on information which is retrieved from death certificates by coders in the Bureau of Vital Statistics, California Department of Public Health. There are several possible sources of error in these data:

1) The certificates themselves may not accurately reflect the nature of the death or the events leading up to it.

2) Vital statistics coders are bound by conventions which often make it difficult if not impossible to accurately summarize what happened. For example, they are required to assign a single cause-of-death code to each case, when in many cases, there is no single cause, but a complex of multiple and interdependent causes.

3) Vital statistics coders are not medically trained, and etiological misinterpretations sometimes result.

Sources of error--particularly the first-mentioned source of error--may be especially serious in poisoning cases. For one thing, the average physician was taught little toxicology in medical school, and the little he was taught may have been rendered largely obsolete by the recent proliferation of pesticides, industrial chemicals, and household preparations. For another thing, poisonings are an unusually sensitive area, in which full information may be withheld for insurance purposes, to "protect" the family or for other reasons. Furthermore, it often takes a long time to reconstruct precisely what happened in a poisoning case. By the time the relevant facts are known, a death certificate may already have been processed through the local jurisdiction to the State Bureau of Vital Statistics, and the full story may never catch up with the original document. The coding on which all mortality statistics are based, it should be noted, is performed at the State rather than the local level.

It is proposed that the death certificates in selected counties during a selected period of time be re-examined, with a particular view toward identifying cases of poisoning, or possible poisoning, which were overlooked in the State's vital statistics because of any of the sources of error mentioned above. It is proposed to use the counties of Sacramento and San Francisco (and perhaps Orange County), because they have an unusually favorable autopsy rate; it is proposed to use the agricultural and largely rural counties of Merced and Stanislaus to correct for the urban bias of Sacramento and San Francisco. All cases in which it is even remotely suspected that any type of poison may have been involved will be checked against the county coroners' reports.

After the search, and adjustments in cause-of-death coding as indicated, the resources of the Department's Data Processing Center will once again be called upon. The Center has on computer tape key information from all death certificates through the first half of 1967. It will thus be relatively simple to construct "before and after" death rates for the counties and causes of mortality with which we are concerned--that is, rates before our follow-up inquiries (these are the official rates), and the rates which would obtain if our adjustments were to be accepted.

Assume that the death rate from poisonings of all types was officially reported to be 2.2 per 100,000 population in the counties in question during the time period in question. Assume that we calculated the true rate to be 3.3 per 100,000 population, with another 1.1 uncertain but "possible." We might then be justified in concluding that poisoning deaths are underreported by at least one-third, and quite possibly by as much as one-half. Even this would be conservative, since there will undoubtedly be many cases in which the death certificate contains no clues of any kind suggesting the need for follow-up inquiry, and in which there was no coroner's investigation.

E. Interviews with a High Risk Population.

It would seem to go almost without saying that the group most at risk from pesticides and other agricultural chemicals consists of agricultural workers. Although farm laborers are excluded from workmen's compensation insurance in many states, in California they have been covered since 1959. Under the California Act, whenever an employee receives medical attention other than ordinary first aid for a work-connected injury or illness, the attending physician is required to file a Doctor's First Report of Work Injury with the State Department of Industrial Relations.

Statistics for the most recent year available, 1966, indicate that 704 such reports were filed for cases of occupational disease attributed to pesticides and other agricultural chemicals, involving agricultural wage workers. It should be noted that "occupational disease" is conceived liberally. No laboratory confirmation need be obtained; in at least 60% of the agricultural chemical cases, no days are lost from work; the only constant criterion is that a physician has been seen.

The Department of Employment reports that slightly over 700,000 different persons work for wages in agriculture at some time during the year in California. Thus, even if each of the 704 reported cases of industrial poisoning in agriculture represented a different worker (which is almost certainly not true), only about one out of a thousand workers appears to be affected each year.

The official reports are sometimes worded in such a way that they suggest this is the true incidence rate of occupational poisonings in agriculture. Interviews with agricultural workers themselves suggest something radically different. Particularly in interviews with grape, nut, and tree fruit workers, any suggestion that only one in a thousand farm laborers feels untoward effects from agricultural chemicals during the year is met with outright amusement. Practically everyone, it seems, can recount either a personal experience or something that has befallen a relative or acquaintance. Grapes, peaches, and oranges appear to be among the crops in which workers most commonly experience the effects of pesticide residues. Indeed, the experience is so common that workers sometimes shrug when the subject is raised, and dismiss it as one of the "givens" in this type of work--something that must be accepted just as one must accept the fact that there will be times when one must work in the heat, in the cold, in the dust, or in the rain--unpleasant but unavoidable.

Since grapes, peaches, and oranges are also among the crops which use the largest numbers of workers in California, preliminary discussions conducted to date with agricultural workers cast doubts of the gravest order on the validity of published figures. The question is not whether physicians file reports when they treat agricultural workers; there is no reason to think they do so any less conscientiously than when they treat workers from any other industry. The question is whether agricultural workers tend to seek medical attention when they are suffering from occupational poisoning--or, for that matter various other types of illness or injury, job-related or not.

There are many reasons why agricultural workers might not seek a physician's care with the same frequency as other classes of workers. Among these reasons are the following:

1. The majority of California's farm workers are of Mexican extraction. At a conservative estimate, 65,000 are "green carders": i.e., citizens of Mexico, who enter the U.S. under visas, and return to Mexico periodically. Probably even more are first generation immigrants: permanent residents of the U.S., but without citizenship. Very few "green carders" and first generation immigrants are literate in English; most are unfamiliar with the spoken English language To them, signs warning that an orchard has been sprayed with parathion are meaningless. Signs posted in Spanish are only slightly more helpful since many Mexicans, particularly those of the rural laboring class, are illiterate in their native language.

2. For the same reason, notices of rights under Workmen's Compensation, Disability Insurance, or other social legislation are likely to be lost on a substantial proportion of the California farm labor force.

3. Many agricultural workers are dependent on word-of-mouth from their immediate supervisor for knowledge about Workmen's Compensation or other rights. The supervisor is usually not the grower, but a crew leader, labor contractor, or other intermediary. Often, the supervisor is himself a recent immigrant from Mexico and unfamiliar with American laws and customs. In other cases, he is too busy to transport a worker to the doctor, and he uses his authority or ingenuity to convince the worker that a visit to a doctor is not really necessary. "We Mexicans are muy macho (very manly). We don't let a little thing like that bother us, do we?"

4. Although a majority of occupational poisonings in agriculture known to the authorities are reported by the attending physician to involve "no time lost," there is in fact no such thing as an agricultural industrial accident which does not involve a loss to the worker. The time spent traveling to and from the doctor, and waiting in his office, always represents a loss of income to the worker, since sick leave is unknown in agriculture. There may be no full days of work missed (the only terms in which "lost time" is called for on the Doctor's First Report of Work Injury), but even an hour or two of wages is an important consideration to the average farm laborer. Given a choice between such a sacrifice, and the discomfort of dizziness, or eye or skin irritation, many farm workers choose to bear the discomfort.

5. Distances in rural California are great. It may be twenty miles to the nearest physician and more than that to the nearest emergency hospital. The waiting room is usually overcrowded when one gets there, since the physician-population ratio is far less favorable than it is in urban communities.

* * * * * * * * *

For these and other reasons, agricultural laborers frequently continue working when they are suffering from symptoms which would long since have sent the average industrial worker to a physician. Even when the nausea or other symptoms cut so deeply into productivity that a farm worker leaves the orchard, his first thought is usually not a physician, but simply to go home and "sweat it out." When they are "back on their feet" in a day or two, they customarily do not report their experience to anyone. In the highly fluid farm labor market, they seek work in some other orchard or vineyard. By a crude trial and error system, without understanding what has happened to them or why, they may find a place of employment where the spraying has been less heavy and their symptoms do not reappear.

The questions are:

1. How widespread is this process?

2. How great is the disparity between agricultural workers who are actually ill from pesticides and those who come to the attention of government agencies through the Workmen's Compensation program? through poison information centers?

3. Is the disparity increasing or decreasing?

4. Where is the need greatest for improved education of growers, foremen, workers, and health personnel?

It is believed that the only way to answer these questions is to interview agricultural workers themselves. Neither employers, labor contractors, agricultural extension agents, physicians, nor anyone else can estimate, even approximately, the frequency with which agricultural workers suffer the symptoms of mild pesticide poisoning and "sweat it out."

We propose to begin by designing a small sample study of agricultural workers in crop-areas where large amounts of pesticides are known to be used. The sample will be stratified in terms of ethnic group, permanence of farm employment, place of residence, type of farm, and so forth. Informants will be asked to reconstruct, as accurately as they can, their employment pattern during the previous season. On occasion, it may be possible to verify their recollections by employer records; on other occasions, there will be no way to do so.

Informants will then be asked to recall their health and sickness experience during the same period. To facilitate their recollections, a list of symptoms will be read to them, and explained as necessary. To avoid selective recall, the symptoms which are most likely to be associated with pesticide poisoning (abnormal fatigue, vertigo, salivation, vomiting, etc.) will be "masked" by a number of other symptoms which are not of central importance to the study (fever, pain in the joints, chronic cough, backache, etc.). Finally, respondents will be asked a series of questions about severity of symptoms, duration, and medical or other care received, if any.

Informants will not be asked for their opinions on whether or not agricultural chemicals were involved. As a matter of fact, pesticides will not specifically be mentioned at any point in the questionnaire. (If a respondent volunteers his own ideas concerning causation, however, they will be duly noted.) The linkage between a suggestive symptomatology and a possibly causative chemical agent will be drawn by matching the informant's employment and morbidity records against the community's "pesticide profile." From records in the office of the county agricultural commissioner, it will be possible to say what pesticides were used on what farms, when, how much, and in what strength; it will therefore be possible to say whether pesticides could have been associated with a given set of symptoms. This, of course, is different from saying for a certainty that they were associated. After the fact, it will not be possible to analyze stomach washings, residues on clothing, or conduct other positive tests. But it will be highly suggestive if Juan Diego reports that he became so dizzy he almost fell off a ladder at the John Doe Ranch, on or about August 1, and the agricultural commissioner's records reveal that John Doe was given a permit to spray with TEPP on June 15 and again on July 15.

On the other hand, if Pito Perez reports that he became nauseated while working at Joe Doakes' Ranch on or about September 1, but records reveal that Joe Doakes did no spraying of any kind after June 1, the case will be classified as very probably not due to pesticides. We cannot rule out altogether the possibility that Pito Perez might have come into contact with some pesticide off the job, but we will be in no position to conduct exhaustive follow-up investigations of such cases. In any event, we can say with assurance that Perez did not suffer from job-related pesticide poisoning, and that is the important point. The main substantive purpose of the sample study will be to assess the extent of underreporting of job-related poisonings among agricultural workers. Workmen's Compensation records will be the yardstick against which our findings will be placed.

Realistically, however, the main accomplishments of such a pilot study in the first year will be methodological rather than substantive. It will be a real accomplishment if a questionnaire is standardized, in both English and Spanish, which yields meaningful information about employment history and sickness experience. It will be a real accomplishment if a method is found to draw a representative sample of a "problem population" which is heterogeneous and frequently mobile. It will be a real accomplishment if a technique is devised to link systematically the information obtained from farm worker interviews with information about the use of pesticides in the immediate area of employment.

It is believed that we will be doing well, during the first year, if we successfully pretest such methods among workers in a single crop-area, such as peach pickers of Stanislaus County, citrus workers of Tulare County, or grape workers of Kern County. (In the latter case, we would have the advantage that Community Studies on Pesticides has already constructed a "community profile"). To apply the basic method to other crops and other areas, pointing eventually toward extrapolation to the entire farm labor force in California, will obviously require more staff and more time. It is equally obvious that further studies will be required in order to answer the vital question: is the rate of pesticide-related morbidity going up or down, or is it remaining about the same? This question will become particularly crucial when (as is hoped)programs of prevention are instituted or strengthened. In no other way can the effectiveness of such programs be evaluted,it would seem, than by follow-up population surveys of roughly the type envisioned here.

Not the least of the aims of the Morbidity and Mortality Study of Poisonings, then, will be detailed recommendations concerning the number of years, personnel, and dollars required to arrive at convincing conclusions as to the incidence of agricultural chemical morbidity over space and over time.

SPUTUM CYTOLOGIC STUDY OF PESTICIDE EXPOSURE

Adequate supplies of materials to assemble the sputum collection kits needed to begin the nationwide survey of pesticide workers are still not available. Access to funds allotted by Atlanta in June, 1968, was delayed by various Federal, State and University processing offices. During this period of delay, efforts to expedite completion of the lengthy processing of the contract to the point of receiving necessary purchasing authorization were not immediately successful. An authorization to proceed with necessary purchases was received on July 31 and supply orders to vendors were started that date through the usual purchasing channels. At the time of this writing, firm promises of prompt delivery have been received.

Use of supplies on hand permitted the study to assemble approximately one-half the number of kits needed to carry out the sputum collection survey among the several participating states. Kits were sent first to the areas believed to be faced with the most critical seasonal timing for specimen collection. Accordingly, sputum kits have been provided to the following projects:

Date Sent	Project	No. of Kits	No. Spec. Received
6/21/68	04 Texas	140	0
July, '68	02 California	95	70
8/5/68	01 Arizona	75	0
8/5/68	05 Hawaii	50	0
8/5/68	08 Louisiana	60	0
8/5/68	11 Mississippi	155	0
8/6/68	03 Colorado	75	0
8/6/68	04 Florida	123	0
8/6/68	14 South Carolina	160	0
		933	70

Sputum kits will be sent to the following projects immediately upon receipt of additional supplies:

06 Idaho	75 Kits
07 Iowa	98
10 Michigan	120
12 New Jersey	115
13 Puerto Rico	100
16 Utah	100
17 Washington	75
	683

In addition to the long-term study population in the California Project, arrangements have been completed to study the following pesticide-worker populations:

1. Follow-up specimens from participants in the 1967 season study	113 cases
2. Personnel from the 60 districts of California Mosquito Control Agencies	170
3. New agricultural aircraft crop control workers	75
	358

The total population from whom sputum samples are to be solicited will consist of:

Community Pesticide Study Projects	+ 933
	683
	+1,616
Additional California occupational populations	358
	+1,974
Off-season repeat sample from each case	1,974
	3,948

COMPUTER PROGRAMS:

A. Recording of Data: The cyto-gram form used in a previous study of other occupational groups has been redesigned specifically for study of the pesticide exposure populations. The microscopic observations as well as the coding of individual histories will be recorded on a single form for each case. Completed cases will periodically be accumulatively transferred to disc via optical scanner and punch cards automatically prepared for secondary storage of data.

B. Print-out: A program has been designed to provide a single page print out of all historical information and a listing of all deviating cytologic characteristics observed in the individual's sputum. The summary statements will discuss the pertinence of these deviations in terms of:

A. INFLAMMATION
B. IRRITATION
C. BRONCHIAL OBSTRUCTION
D. ALLERGY
E. CELL CHANGE

An example of print-out form is to be found on i and ii (attached).

C. Computer Analysis of Data: The information stored on disc will be periodically analyzed using a slightly modified existing program. Analysis will be made of the frequency distribution of observed cytologic deviations with reference to occupational category, length of employment, details of pesticide exposure, smoking habits, and clinical symptoms.

(SAMPLE COMPUTER PRINT-OUT)

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                                SPUTUM CYTOLOGIC STUDY OF PESTICIDE WORKERS                       i

CYTO. NO.:  0052                                                                AMA ID NO.: 031318JD11

SOURCE:                             02 (CALIF. STATE DEPT. OF PUB. HLTH.)
SPECIMEN COLLECTED:                 JULY, 1968
                  * * * * * * * * * * * * * * OCCUPATIONAL DATA * * * * * * * * * * * * * *
CURRENT OCCUPATION:                 04 (SWAMPER)
LENGTH OF EMPLOYMENT:                3 YEARS

CLAIMED PESTICIDE EXPOSURE:         FREQUENT WORKING CONTACT WITH PESTICIDES
                                    HEAVY EXPOSURE
                                    MOST FREQUENTLY USED:
                                            - 290-(04):   PARATHIONE
                                            - 386-(04):   TEPP
                                            - 111-(00):   DIBROMSALICYLANALIDE
                                    WORKS MAINLY WITH SPRAYS
                                    OCCASIONALLY WEARS PROTECTIVE CLOTHING
                  * * * * * * * * * * * * * *SYMPTOMS CLAIMED * * * * * * * * * * * * * * *
COUGH:                              COUGHS FREQUENTLY
SPUTUM:                             RAISES SPUTUM IN MORNINGS ONLY
ALLERGY:                            IS ALLERGIC TO PLANTS, EFFECTING EYES & NOSE
                  * * * * * * * * * * * * * * SMOKING HABITS * * * * * * * * * * * * * * *
STATUS:                             CURRENT SMOKER
TOBACCO FORM:                       CIGARETTES
DAILY AMOUNT:                       20 CIGARETTES
YEARS OF SMOKING:                   20 YEARS
CIGARETTE/YEARS                     400
                  * * * * * * * * * * * * * * CYTOLOGIC DEVIATIONS OBSERVED * * * * * * * *
LEUCOCYTES:                         INCREASED NUMBERS, PURULENT
FIBRIN:                             INCREASED QUANTITY
MACROPHAGES:                           -BORDERLINE INCREASED NUMBERS
TOTAL BRONCHIAL CELLS:                 -BORDERLINE INCREASED NUMBERS
METAPLASIA:                         3 PLUS QUANTITY
                                       -SLIGHTLY ATYPICAL FORMS
LEUCOCYTIC INCLUSIONS:              PRESENT
EPITHELIAL PLUGS:                   PRESENT
CURSCHMANN'S SPIRALS:               PRESENT, 2 PLUS QUANTITY
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(SAMPLE COMPUTER PRINT-OUT CONTINUED)

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SUMMARY OF POSITIVE CYTOLOGIC FINDINGS:

  I.   INFLAMMATION:
       A MARKED INCREASE IN NUMBER OF PUS CELLS IS SEEN, WITH NO OBVIOUS DEVIATION IN PMN:MONO. RATIO

 II.   IRRITATION:
       A BORDERLINE INCREASE IN NUMBER OF PULMONARY MACROPHAGES IS OBSERVED WHICH IS CONSISTENT WITH THE CLAIMED
            SMOKING QUANTITY.
       SOME DEGREE OF BRONCHIAL IRRITATION IS SUGGESTED BY A SLIGHT INCREASED SHEDDING OF BRONCHIAL EPITHELIAL CELLS.

III.   ALLERGY:
       NO EVIDENCE IS SEEN TO SUPPORT THE INDIVIDUALS CLAIM OF ALLERGY TO PLANTS.

 IV.   OBSTRUCTION:
       A MODERATE NUMBER OF CURSCHMANN'S SPIRALS ("BRONCHIAL CASTS") ARE PRESENT.
       THE FIBRIN CONTENT OF THE SPUTUM IS SLIGHTLY INCREASED SUGGESTING THAT THERE HAS BEEN
            SOME DELAY IN RETROGRADE FLOW OF THE BRONCHIAL SECRETION.

  V.   CELL CHANGE:
       MANY DYSKERATOTIC CELLS ARE SEEN WHICH ARE SUGGESTIVE OF CELLS SHED FROM SQUAMOUS METAPLASIA
            OF BRONCHIAL EPITHELIUM. SLIGHTLY ATYPICAL FORMS ARE SEEN AMONG THE "METAPLASTIC CELLS".
            MATURE (KERATINIZED) FORMS PREDOMINATE.
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COMMUNITY PROFILE OF IMPERIAL COUNTY

This study involves gathering information on pesticide usage, meteorological data, mortality and morbidity rates, economic characteristics, educational achievement, demographic characteristics and environmental monitoring in Imperial County, California. The completed community profile will be submitted at the end of 1968 as part of this project's annual report.

All of the demographic material referred to in Quarterly Report #12 has been molded into the now completed demographic section of the Community Profile. In the body of the final report, the emphasis will be on an interpretative analysis of the data collected. For example: Imperial County ranks first among the fifty-eight counties in California for persons with a Spanish surname who comprise approximately 33% of the County's total population. The impact of this large minority group on personal income, median school years completed, domestic farm employment, and other demographic characteristics will be discussed in the body of the final report.

Also completed, and probably the most significant section of the Community Profile from an economist's viewpoint, is the agricultural production section. Imperial County is known nationwide for its year around agricultural production. It ranks sixth among all counties in the nation in gross income from agricultural products. In fact, essentially all other business and service agencies in the County are directly or indirectly related to the agricultural industry; and, their success and continuing existence depends entirely upon the viability of the basic industry. The lack of a diversified economy is reflected in the designation of Imperial County, in 1966, as a redevelopment area under the Public Works and Economic Development Act of 1965.

The Imperial County Agricultural Commissioner publishes yearly reports on agricultural production in the County. His reports are the background of the information presented in the Community Profile. This section of the report has as its principle objective to analyze and explain the economic trends of the past eight years which have lead to the present production levels.

The success of Imperial County agriculture is principally due to one ingredient, imported water. A large portion of the formerly desert valley has been converted into lush farmlands through the importation of water from the Colorado River. Indeed, the supply and drainage complex for Imperial Valley is unique in its simplicity. The water story is so important that a separate section has been devoted to it; included are the domestic and agricultural uses and wastes, the input canal and drainage systems, and the physical and chemical characteristics of the input and drainage waters.

The major task which remains before a community profile of the County is complete,is to develop the local pattern of pesticide usage for the report. At present, staff members are continuing the collection of pesticide usage data for this and another related work unit; i.e., the prospective study of environmental factors related to the incidence and rate of neonatal jaundice in the County. Therefore, this section of the Community Profile will provide the most complete and updated information available. Present plans are to provide pesticide usage data by the number of pounds of active ingredient applied each month and the number of acres receiving applications during each of the years 1967 and 1968.

The gathering of these data from the several resource agencies cooperating in the study, will proceed as planned during the ensuing four and on-half months of the current contract year. Following completion of their collection, analysis of the data will be undertaken, correlations with selected meteorological and demographic characteristics established and a final report written.

PESTICIDE RESIDUES IN HUMAN TISSUES

Arrangements previously described in Quarterly Progress Report No. 13 were made with the Alameda County Coroner's office to furnish the project with autopsied human adipose tissue and whole blood from 105 deceased residents. These tissues have been received and delivered to the project's pesticide laboratory in Berkeley for analysis for selected chlorinated hydrocarbon pesticide residues.

In the thirty adipose tissue samples so far analyzed, 4 pesticides have been identified: pp' DDE in all 30 of the samples (mean value 12 ppm); pp' DDT in 29 samples (mean 2.2 ppm); B-BHC in 27 samples (mean 0.42 ppm); and dieldrin in only 11 of the samples (mean 0.28 ppm). The mean values and high and low values for all 30 adipose tissue samples for each pesticide are presented in the accompanying table and are detailed by sex and racial subgroups for comparison and study.

The mean DDT level for all 30 adipose tissues (2.2 ppm) is considerably lower than the concentration of DDT in various whole tissues from the general United States population (6.8 ppm) as reported by Quinby, et al, 1965(1). However, the two methods of analysis and reporting may be different in the two laboratories and therefore may contribute to their disagreement.

During the contract year of 1967, a total of 101 autopsied tissues from 18 persons were received from Kern County General Hospital and analyzed for selected chlorinated hydrocarbon pesticide residues. The results of these determinations have been sent to the Office of Pesticides (Quarterly Report No.11). Kern County's basic economy is agriculture. In 1967, the gross value of the County's agricultural income exceeded 300 million dollars, making it the third highest ranking area in the nation. The highest ranking areas are California's Fresno and Tulare Counties which are located immediately north of Kern County in the southern portion of the great Central Valley.

Alameda County, on the other hand, is an industrial - residential county within the San Francisco Bay Area and where agriculture plays a minor role in the total economy. As might be expected, therefore, higher levels of pp' DDT and pp' DDE were found in autopsied adipose tissue from residents of Kern County (4.3 ppm and 15.5 ppm, respectively) than in the adipose tissue samples from residents of Alameda County (2.2 ppm and 12 ppm, respectively). Interestingly, however, B-BHC* and dieldrin were identified in a greater number of the adipose tissue samples from Alameda County than in tissues from Kern County.

The relative ranking of the various subgroups by race and sex with respect to pesticide levels, are similar for both Alameda County and Kern County samples. In order of decreasing pesticide content, the overall ranking is: Negroes > Whites and males > females. The rating by components for the Alameda County group shows Negro males > White males > White females > Negro females. However, conclusions from these data must be guarded because, among the 30 adipose tissue samples analyzed to date from Alameda County, there are only 8 Negroes (5 male, 3 female).

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(1) DDT Storage in the U.S. Population; JAMA 191:175-179.

* B-BHC and dieldrin were found in only a few of the Kern County samples so mean values were not available for comparison.

Because of the variation in "normal" population levels of pesticide storage, the most useful criterion in determining which individuals have high or low pesticide residue levels would be any level ± 2 standard deviations from the mean. Once all the 105 samples have been analyzed, this criterion can be firmly established.

Among the 30 specimens analyzed, four cases are of special interest: two of them were Negroes with high pesticide content and two were Caucasians with low pesticide content. One Negro had been an agricultural laborer for 15 years and ranked first in pp' DDT level (15 ppm), first in pp' DDE level (57 ppm), and third in B-BHC content (0.71 ppm). Another Negro, a long-time chauffeur, ranked third in pp' DDT level (5 ppm), second in pp' DDE level (53 ppm) and first in B-BHC content (1.1 ppm). All of these levels are well in excess of the calculated means for the entire group. These two cases illustrate a unique feature common to the tissue samples thus far analyzed from Negroes in that neither contained an identifiable amount of dieldrin. At the other end of the spectrum,a White male independent lumberer, had no pp' DDT, dieldrin, or B-BHC and only 1.2 ppm pp' DDE. A White housewife, contained no dieldrin and had very low levels of the other pesticides.

In the whole blood samples, 5 different pesticides were identified: pp' DDT, pp' DDD, pp' DDE, dieldrin and B-BHC. Since only 15 samples of blood have been analyzed to date, no statistics have been computed on this set of data.

The pesticide levels in the 30 adipose tissue samples are approximately 1000 times higher than the pesticide levels in the whole blood samples.

Analysis of the remaining 75 adipose tissue samples and 90 blood samples from Alameda County are expected to be completed by the Pesticides Laboratory during the ensuing quarter of the current contract year.

When all of the data are available, correlations between urban and rural residents and between occupation will be established and an analytical report completed.

THIRTY ADIPOSE TISSUE SAMPLES FROM ALAMEDA COUNTY
ANALYZED FOR SELECTED PESTICIDE RESIDUES (UNITS ppm)

Number of Adipose Tissues Containing Each Pesticide and the Pesticide Levels Found.	White		Negro		All	All	All	All	All
	Male	Female	Male	Female	Males	Females	Whites	Negroes	Tissues
Number of Adipose Tissue Samples Analyzed	13	9	5	3	18	12	22	8	30
pp' DDT									
Number	12	9	5	3	17	12	21	8	29
Mean	1.7	1.1	6.1	1.4	3.0	1.1	1.4	4.3	2.2
High	3	2.1	15	2	15	2.1	3.0	15	15
Low	0.84	0.1	0.43	0.77	0.43	0.1	0.1	0.43	0.1
pp' DDE									
Number	13	9	5	3	18	12	22	8	30
Mean	10	6.8	30.4	6.1	16	6.7	8.7	21.3	12
High	21	18	57	8.0	57	18	21	57	57
Low	1.2	0.24	2.1	3.3	1.2	0.24	0.24	2.1	0.24
Dieldrin									
Number	7	3	1	0	8	3	10	1	11
Mean	0.27	0.29	0.38	--	0.28	0.29	0.27	0.38	0.28
High	0.42	0.65	0.38	--	0.42	0.65	0.65	0.38	0.65
Low	0.15	0.19	0.38	--	0.15	0.19	0.15	0.38	0.15
B-BHC									
Number	12	9	3	3	15	12	21	3	27
Mean	0.44	0.36	0.72	0.37	0.49	0.33	0.39	0.55	0.42
High	1.2	0.62	1.1	0.52	1.2	0.62	1.2	1.1	1.2
Low	0.17	0.08	0.36	0.14	0.17	0.08	0.08	0.36	0.08
% Fat									
Number	13	9	5	3	18	12	22	8	30
Mean	70	72	55	72.3	65.5	72	70.5	61.5	68.2
High	83	91	93	80	93	91	91	93	93
Low	37	34	28	59	37	34	34	28	28

HUMAN EXPOSURE TO LINDANE

Activities concerned in evaluating the health of persons occupationally exposed to the pesticide lindane have continued during the period covered by this report.

Forty-five employees of the State Department of Public Health volunteered to participate as a control group in the Lindane Study. Accordingly, blood samples were obtained from each volunteer and analyzed for lindane residue by the project's Pesticides Laboratory. The results of the determinations are recorded on the following page. As might be expected, the results indicate that persons "unexposed" to the pesticide under study do not have, in the great majority of cases, lindane residue in their blood which is at a level above the limits of detectability by the analytical method used.

In addition to the above activities, employees occupationally and exclusively exposed to lindane at the Los Angeles plant participating in the study, were programmed for their first follow-up examinations and hematological studies by the California Hematological Laboratory, the project's subcontractor. Redeterminations on these fifty-seven subjects will include a complete hemogram, creatinine, alkaline phosphatase and uric acid. The project's Pesticides Laboratory will perform cholinesterase and pesticides residue level determinations on each subject.

Plans to follow those twelve of the fifty-seven study subjects occupationally exposed to lindane who will be on vacation during the period of this report have been implemented in an effort to determine the rate at which lindane residue is eliminated from their blood following their removal from the contaminated working environment. In this respect, each study subject scheduled for a two, three or four-week vacation leave has had or will have a blood lindane determination performed on his last pre-vcation working day and again on the last day of his vacation and before returning to the plant to resume active employment.

Work on these latter two groups of study subjects is proceeding and will continue to completion during the ensuing quarter. By the end of the current contract year, all data will be statistically analyzed and a final report on the study completed.

LINDANE LEVELS IN CONTROL BLOOD SAMPLES

Laboratory Sample No.	Field Sample No.	Lindane (micrograms/milliter) ± estimated error
68386	1	< 0.0003
68387	2	< 0.0003
68388	3	< 0.0003
68389	4	< 0.0003
68390	5	< 0.0003
68391	6	< 0.0003
68392	7	< 0.0003
68393	8	< 0.0003
68394	9	< 0.0003
68395	10	< 0.0003
68396	11	< 0.0003
68397	12	< 0.0003
68398	13	< 0.0003
68399	14	< 0.0003
68400	15	< 0.0003
68401	16	< 0.0003
68402	17	< 0.0003
68403	18	< 0.0003
68404	19	< 0.0003
68405	20	< 0.0003
68406	21	< 0.0003
68407	22	< 0.0003
68408	23	< 0.0003
68409	24	0.0004 ± 0.0003
68410	25	0.0003 ± 0.0003
68411	26	0.0003 ± 0.0003
68412	27	0.0005 ± 0.0003
68413	28	0.0003 ± 0.0003
68414	29	< 0.0003
68415	30	0.0003 ± 0.0003
68416	31	< 0.0003
68417	32	< 0.0003
68418	33	0.0003 ± 0.0003
68419	34	0.0007 ± 0.0003
68420	35	< 0.0003
68421	36	< 0.0003
68422	37	< 0.0003
68423	38	< 0.0003
68424	39	< 0.0003
68425	40	< 0.0003

INVESTIGATION OF UNIQUE EVENTS

I. INVESTIGATION OF MIXED LOAD OF PARATHION AND ICE CREAM CONES

There follows a report requested from Motor Carrier Safety Unit, Zone 4, of the California Department of Highway Patrol on an event which occurred during the period of this report involving a mixed truckload of pesticides and foodstuff which came to the project's attention one week after the event occurred.

On June 21, 1968, Motor Carrier Safety Unit, Zone 4, California Highway Patrol, received a call from MSCU, Zone 3, requesting information on a mixed load shipment of parathion and ice cream cones transported by a MSCU, Zone 4 trucking firm. The incident came to the attention of MSCU, Zone 3, through a call from the local Safety Engineer, Division of Industrial Relations.

Discovery of the mixed load was made by the Plant Safety Engineer at a chemical company, to whom the pesticides were consigned, when the truck arrived there for unloading. The Plant Safety Engineer informed the truck driver of the mixed load, the hazard it presented, and offered to destroy the ice cream cones. Before accepting the offer, the driver called the trucking firm he worked for and was directed to return the ice cream cones to the warehouse where they had been loaded onto the truck.

Further investigation of the incident by MCSU, Zone 4, revealed the following information:

A call to the local Division of Industrial Safety, California Department of Industrial Relations revealed that the incident had been turned over to the local County Health Department, Division of Environmental Health.

The local County Health Department was contacted who advised that the incident had been processed for a hearing board and could not be discussed at that time.

At an interview two days later with the director and the supervisor of the County Health Department, the mixed load incident was discussed. The Motor Carrier Safety Unit's investigator informed the health authorities of the California Highway Patrol Department's Motor Carrier Safety Regulations governing the Transportation of Dangerous Articles. He also brought to their attention Federal regulations concerned with the transport of Class B poisonous liquids and solids.

The Plant Safety Engineer of the chemical company to whom the pesticides were consigned was called. He stated that one of his dock-men, while preparing to unload a van-type vehicle, opened its doors, recognized the mixed load, and reported it to him immediately.

The Plant Safety Engineer informed the truck driver of the hazardous nature of his cargo. After placing a telephone call to his home office, the driver stated that he had been instructed to return the ice cream cones to their place of origin. The Plant Safety Engineer, unsure that all proper safety precautions would be exercised, called the Safety Engineer at the local offices of the Division of Industrial Safety to express his concern.

Having established the carrier's identity and the warehouse where the truck had been loaded, the president and vice-president of the company operating the warehouse were contacted. The president gave the following version of the chain of events as they occurred for this particular shipment.

On the day before the incident was discovered, his sub-terminal in another part of the State called to advise that a 34 case shipment (otherwise unspecified) was en route to the Main Terminal which, upon arrival, needed to be placed on a vehicle bound in the direction of the address destined to receive the shipment. Previous shipments from the sub-terminal had invariably been hardware items and had not included wearing apparel or edible products. Consequently, little attention was paid to the call except that the shipment needed to be transferred to a properly bound vehicle.

The shipment arrived on the day of the call and was transferred to another vehicle during the early hours of the following day. Neither the president nor vice-president of the warehouse company was present at the time of the transfer or departure of the transfer vehicle and, therefore, were unaware that its load consisted of a mixed load of ice cream cones and a large quantity of parathion and other pesticides. Their first knowledge of the situation was received when the truck driver called in to inquire about what he should do with the 34 cases of ice cream cones and was instructed to return them to the warehouse as soon as he had completed his delivery at his then present location.

Upon return of the driver to the warehouse with the ice cream cones, they were placed on the loading dock to await the arrival of local health authorities. The warehouse officials had the truck inspected for evidence of pesticide spillage. None was found. As part of the company's normal policy, the vehicle was decontaminated.

The local health officials arrived subsequently, discussed the mixed shipment and, with the consent of warehouse officials, departed with the ice cream cones (which were later destroyed) and with test samples of similar pesticides stored in the warehouse and which were part of the mixed load.

Further conversation with the president of the warehouse company revealed that large shipments of insecticides from several large chemical plants arrive several times a week by rail car for storage in his warehouse. The products are received in sealed, legal containers. Any leaking containers are reported immediately to the shipper involved who furnishes the experts in decontamination.

Examination of the shipping documents for the load in question revealed that it contained:

29 - 550 lb. drums Methyl Parathion - 98.5%

8 - 550 lb. drums Ethyl Parathion - 98.5%

100 - 24 lb. cases Dacthal W75

20 - 5 gal. cans Banvel D (Dicumba)

34 - cartons ice cream cones

No poisonings resulted from this incident, possibly because of the alertness of the dockman at the chemical plant destined to receive the pesticides shipment, and the prompt and effective action of several other involved and responsible persons concerned with the matter. The incident does, however, point up again the need for all levels of personnel handling, storing and transporting pesticides to understand and appreciate their hazardous nature, the need to exercise diligent precautions in managing and handling them, and the need to rigorously avoid transporting pesticides as part of loads mixed with edibles or wearing apparel. A less fortunate conclusion of the incident described above could have cost serious illness and perhaps loss of life among persons who consumed foodstuff inadvertently but avoidably contaminated with highly toxic pesticides.

Even with rigorous, effective and frequent training and educational courses in the health hazards and safe management aspects of pesticides for persons at all levels engaged in their commercial manufacture, transport, storage, and use, accidents will happen. The questions that still remain, however, are whether such courses are programmed, reach all levels of personnel, are sufficiently frequent, and whether the training and educational techniques used have been evaluated for effectiveness.

II. ACCIDENTAL CONTAMINATION OF THE PAJARO RIVER WITH ENDRIN

On April 19, 1968, the Bureau of Sanitary Engineering, State Department of Public Health, was advised by telephone that contamination of a reach of the Pajaro River in Monterey County with the pesticide Endrin had occurred with a resulting fish kill.

Upon investigating the incident, it was learned that 10 days earlier, Endrin had been applied to an undetermined acreage of land on the Pajaro River watershed at an inadvertent rate of 1 gallon/acre rather than at the usual rate of 1 quart/acre. Dispersion of the pesticide from the land area began two days following the application and the fish kill was reported an additional three days hence, at which time the material appeared to be concentrating in a lagoon upstream from the mouth of the river and in the vicinity of Sunset Beach State Park on the ocean.

A call to the Fish and Game Warden in the area was made to learn what had been done about the situation and if the mouth of the Pajaro River was open to the ocean at the time. This latter fact could be significant in evaluating the degree of hazard to nearby clam beds. The warden advised that the river's mouth was open to the ocean and proceeded to relate the following details of the incident.

On April 15, a rancher reported many dead fish in the Pajaro River near where Highway 101 crosses it. On the same day, a Fish and Game Inspector confirmed the report and stated that the river was unaffected above the upstream point where Uvas Creek empties into it. Upon following Uvas Creek upstream to a point where a small flow from a ditch into the Creek occurred, the inspector found that above this point, wildlife along Uvas Creek appeared unaffected but was a total loss below it. The course of the ditch was traced to a flowing artesian well near a tomato field. Four empty yellow cans labelled "Endrin" were found in a field not far from the ditch. Upon questioning a field worker, it was learned that a pre-plant spray of Endrin had been applied to the fields on April 10th or 11th and that the fields had been irrigated two days later.

The Santa Cruz County and the Monterey County Health Departments were contacted and both were found to be unaware of the incident. Thereupon, the incident and the potential hazards from it were described and discussed with them.

The Director of the Moss Landing Marine Laboratory was contacted and recommended that samples of ocean plants and shellfish be collected and analyzed to determine whether the toxic pesticide was being concentrated in them in quantities which would be hazardous to humans who might take and consume the shellfish or fish. This recommendation was considered important inasmuch as fish kill was observed in the Pajaro River several miles downstream from the point of the application of Endrin and as far away from it as Watsonville, a short distance from the ocean.

Accordingly, samples of shellfish, fish, water and soil were collected and sent to State Laboratories in Sacramento for analysis. The samples collected were taken from beaches on both sides of the mouth of the Pajaro River in spite of the fact that the river flow is generally swept south upon entering the ocean, thus affecting the south shore aquatic life. Under certain conditions, however, the usual southward sweep does not hold true. It was also noted that the legal season for taking shellfish from the area regularly closes on April 30 of each year.

A final report on this incident will be made as soon as sectional reports from the several involved and responsible agencies have been received.

III. APPLICATION OF SODIUM FLUOROACETATE (1080) AND ZINC PHOSPHIDE FOR RODENT CONTROL.

In early July, 1968, the State Department of Public Health was notified by the Federal Food and Drug Administration of a growing concern about reports that Sodium Fluoroacetate (1080) was being applied around artichoke fields in Monterey County for control of a very large infestation of field mice, and requested the Department to investigate the matter.

The Department's Bureau of Vector Control was contacted and where it was learned that a meeting on the problem of field mice in artichoke fields and their control had been held in late June. A representative of the Bureau attended the meeting out of concern with mice as vectors of human disease. Although the subject was introduced at the meeting, no decision on the use of 1080 to control mice was arrived at then or at a later meeting during the first week in July.

From information subsequently secured, it appears that plans had been made to use 1080 in an effort to control the infestation of mice in about 8000 acres of artichokes. The plans called for treatment of selected test areas. Further information revealed that the mice were eating artichokes as a secondary choice of food inasmuch as their usual weed and plant seed food source had become exhausted. The mice were also eating artichoke plant stems underground, causing many of the plants to die.

Prior to July, the County Agricultural Commissioner had sold zinc phosphide treated grain to farmers to place around the base of the artichoke plants in an attempt to control the mouse infestation. This method of control did not prove effective because of poor acceptance of such treated grain by mice.

At this point, the State Department of Fish and Game was called who stated that although no final decision had been made on the choice of rodenticide to be used, 1080 was their preference over zinc phosphide because it was less hazardous to birds.

The County's Health Officer was called and a meeting arranged by him with representatives of the Department of Fish and Game, artichoke growers and chemical manufacturing companies. Subsequently, it was decided with the County Agricultural Commissioner that 2 ounces of 1080 per 100 pounds of oat groats would be applied by air to 80 acres of "wasteland," at a rate of 6 pounds of oat groats per acre. In addition, it was planned to apply zinc phosphide to nonbearing artichoke fields at a rate of 1.7 pounds per 100 pounds of oats at a rate of 6 pounds of oats per acre.

At the above concentrations in oat groats and at the above rates of application, it can be calculated that a dangerous oral dose of 1080 to man (5 to 35 mg.) is contained in from 0.15 oz. to 1 oz. of oat groats. At an application rate of 6 lbs. (3360 mgs. of 1080) per acre (43,600 sq. ft.), a 5 mg. dose of 1080 would, if applied evenly, cover about 60 sq. ft. For zinc phosphide at 1.7% in oats, a dangerous oral dose to an adult human (1-2 grams) would be contained in 2 oz. of oats; and, if applied evenly, 1 gram of zinc phosphide would be spread over 1100 sq. ft. If 80 acres are treated with 1080 once, there would be dispensed 267 grams of 1080 or 53,000 dangerous doses. In 8000 acres of artichokes, if all were treated once with zinc phosphide, there would be dispensed 384,000 grams of the chemical or 384,000 doses dangerous to humans.

The County Agricultural Commissioner was satisfied that the planned applications of 1080 and zinc phosphide were safe, but felt there might be some bird losses.

It was suggested to the County's Health Officer and Agricultural Commissioner that all medical facilities in the area be informed that large amounts of the two highly toxic pesticides were to be used. Even so, because symptoms of poisoning by 1080 can be delayed, because treatment is not very effective, and because no chemical tests are available to assist in the diagnosis of such poisoning, the diagnosis can be missed. In addition, in the case of fatal poisoning, there are no characteristic postmortem findings to assist in the diagnosis. 1080 is water-soluble and very stable.

Zinc phosphide is highly toxic and produces its effect by liberating phosphide gas - particularly when acted upon by gastric acid. Nausea, vomiting, shortness of breath and collapes can appear suddenly. Swallowing small amounts of either 1080 or zinc phosphide or breathing dusts containing them are very hazardous.

The toxicity of 1080 varies widely among species and even among strains of the same species. Its LD_{50} varies from 0.06 mg./kg. for the dog to over 500 mg./kg. for the toad. 1080 is translocated in plants and is the active ingredient in the poison plant "gifblaar" of South Africa, - one of the most deadly poisons known to cattle and other stock.

For these reasons, whenever 1080 is applied, it is important to pick up and properly dispose of the carcasses of dead animals promptly because they are deadly to predators which should be preserved. A dog or cat can be killed by eating one poisoned mouse; humans can be poisoned by eating poisoned game.

There is no practical laboratory method for accurately monitoring 1080 in the environment such as water, shellfish, fish and game or other wildlife, crops, soil or air. An existing method is not sensitive but is specific except for one interference. No gas chromatographic method has been developed; biological screening is limited and expensive; no tolerances have been established for either zinc phosphide or 1080 in edible crops.

From the standpoint of human health and environmental contamination, the use of 1080 and zinc phosphide, by whomever and wherever applied, raises a number of important questions. In the area of precautionary measures, what precautions should be taken regarding the storage, monitoring, and disposal of poisoned grain so that it is all accounted for and available only to well-trained and authorized personnel? Since zinc phosphide must be stored under special conditions (dry, cool, away from oxidizing agents, flammable with acids), are these precautions being observed in the storage of poisoned grain and the zinc phosphide? Are fire department personnel aware of the hazardous nature of these materials and how to manage them? What precautions should be taken by persons who mix the pesticides with grain and apply it? Are they aware of the dangers of contamination of themselves, their lunches, tobacco and families?

In the area of research and evaluation, what studies should be undertaken to assure that the environment and its elements and useful organisms will not be dangerously contaminated through the use of these chemicals? What studies and monitoring of the environment need to be undertaken to determine the results of these applications? What drift and other translocation effects of these pesticides might be expected and avoided?

Given the present day environmental contamination problems, it seems unreasonable to dispense these chemicals over large areas of land when there is no method of monitoring them, no permissible tolerances established, when their health, environmental, and ecological ramifications have not yet been evaluated, and when a research project to develop a practical method for chemical detection and analysis of 1080 has yet to be launched.

INVESTIGATION OF FATAL AGRICULTURAL PLANE CRASHES

During the past two months, there have been in California at least eight fatal agricultural plane crashes. Four of them were reported to the project by the appropriate General Aviation District Office of the Federal Aviation Agency and the incidents investigated. The remaining incidents came to the project's attention fortuitously from a variety of sources and well after their occurrence. Consequently, repeat notices are being sent to each of the seven "GADO's" in the State and to the one in Nevada, reminding them of the project's responsibilities and interest in fatal agricultural plane crashes and requesting that one name on the furnished list of project staff members be notified each time a fatal agricultural plane crash comes to their attention.

Each of the four incidents investigated involved collision by the aircraft with a utility pole, a radio transmitting mast or with power lines. In each instance, the plane was consumed by fire, the pilot incinerated and the hopper ruptured with consequent pesticide contamination of a relatively large area of ground surface. Similarly, collisions with surface obstructions appear to have been involved in the incidents coming to the project's attention from unofficial sources and uninvestigated.

A report on each of the four investigated incidents has been sent to the Community Studies Section, Office of Pesticides, Atlanta.